Digitized by the Internet Archive
in 2017 with funding from
IMLS LG-70-15-0138-15

https://archive.org/details/plantsgardens1194unse

BROOKLYN BOTANIC GARDEN RECORD

33
77891
33

PLANTS & GARDENS

1-3

Spring, 1945-47

ayout of the Small Place

—

What's in a Name

—

Shrubs for Special Uses

—

The Living Tree

—

Weed Killing Chemicals

—

Why House Plants Fail

OL. I NEW SERIES NO. 1

BROOKLYN BOTANIC GARDEN
OF
THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

Officers of the Institute

EDWARD C. BLUM
Chairman, Board of Trustees

ADRIAN VAN SINDEREN
President

WALTER H. CRITTENDEN
First Vice-President

CHARLES PRATT
Second Vice-President

SIDNEY W. DAVIDSON
Third Vice-President

EDWIN P. MAYNARD
Treasurer

JAMES E. GIBBONS
Secretary

Ex Officio Members of the Board

The Following Officials of the City of New York

THE MAYOR
THE COMPTROLLER
THE COMMISSIONER OF PARKS

Botanic Garden Governing Committee

PHILIP A. BENSON, *Chairman*

MISS HILDA LOINES, *Vice-Chmn.*
EDWARD C. BLUM, *Ex officio*
WILLIAM G. CREAMER
WALTER H. CRITTENDEN
LEWIS L. FAWCETT
MRS. LEWIS W. FRANCIS
ANDREW J. GONNOUD
WALTER HAMMITT
WILLIAM T. HUNTER
EDWIN P. MAYNARD
ROBERT MOSES, *Ex officio*
ALFRED E. MUDGE
JOHN C. PARKER
DONALD G. C. SINCLAIR
ADRIAN VAN SINDEREN, *Ex officio*

Director of the Botanic Garden

GEORGE S. AVERY, JR.

PLANTS & GARDENS

Opuntia tortispina

New Series Spring, 1945 Vol. 1—No. 1

CONTENTS

Cover....The Richard Young Gate

Frontispiece....The Laboratory Building of the Garden

Announcement....George S. Avery, Jr. 3

Layout of the Small Place....Mary Deputy Lamson 4

What's in a Name?....Henry K. Svenson 6

The Living Tree....Arthur Harmount Graves 11

Shrubs for Special Uses....Charles F. Doney 18

Weed Killing Chemicals....George S. Avery, Jr. 52

Why House Plants Fail....Montague Free 56

Growing Your Own.... 59

Within the Brooklyn Botanic Garden.... 63

Among the Contributors to this Issue....Page 3 of cover

Except where otherwise noted: drawings by Maud H. Purdy, excluding those on pages 52 and 56, which are by Margaret F. Piper; photographs by Louis Buhle.

MONTAGUE FREE, *Editor*

Published quarterly at Prince and Lemon Streets, Lancaster, Pa., by the Brooklyn Botanic Garden, Brooklyn, N. Y. Entered as second-class matter, April 10, 1933, at the post-office at Lancaster, Pa., under Act of August 24, 1912. Subscription included in Botanic Garden membership dues. To others: $2.00 per year; $3.00 for two years.
Copyright, 1945, by the Brooklyn Botanic Garden.

The Laboratory Building of the Garden

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
1000 WASHINGTON AVENUE
BROOKLYN 25, NEW YORK
TELEPHONE: MAIN 2-4433

Spring 1945

TO ALL INTERESTED IN PLANTS:

It is with enthusiasm that we bring you PLANTS AND GARDENS. It stems by direct descent from the "Record", a 33 year old publication of the Brooklyn Botanic Garden, and will appear four times each year, along with the seasons.

The "Record" was chiefly concerned with developments within the Garden. Its pages for more than three decades recorded the happy events, gifts and growth that brought the Garden to remarkable maturity under its first director, the late C. Stuart Gager.

PLANTS AND GARDENS will continue to carry news and views of the Garden and its staff. It has a larger aim too, to make available to a wider audience the horticultural experience gained in this great Garden.

We want to tell the "why" as well as the "how" of garden practices and link up the knowledge of the botanist with the skill of the gardener. We want to keep you abreast of botanical research especially as it is related to horticulture; and to dispense sound information concerning the amazing developments in the realm of synthetic plant hormones, fungicides, insecticides, weed killers, etc. We want, too, to call your attention to worthwhile but little known plant material, and indicate ways in which it can be most effectively used. Part of our job is to see that the horticultural spring never runs dry, and through research here and elsewhere, we are going to do our best to keep it flowing.

If you are a lay horticulturist with an urge for knowing more about the art and science of gardening, then PLANTS AND GARDENS is dedicated to you.

Sincerely yours,

George S. Avery, Jr.
Director

Photo by Richard Averill Smith, N. Y.

A woodland garden

LAYOUT OF THE SMALL PLACE

A woodland garden

Mary Deputy Lamson

Landscape Architect

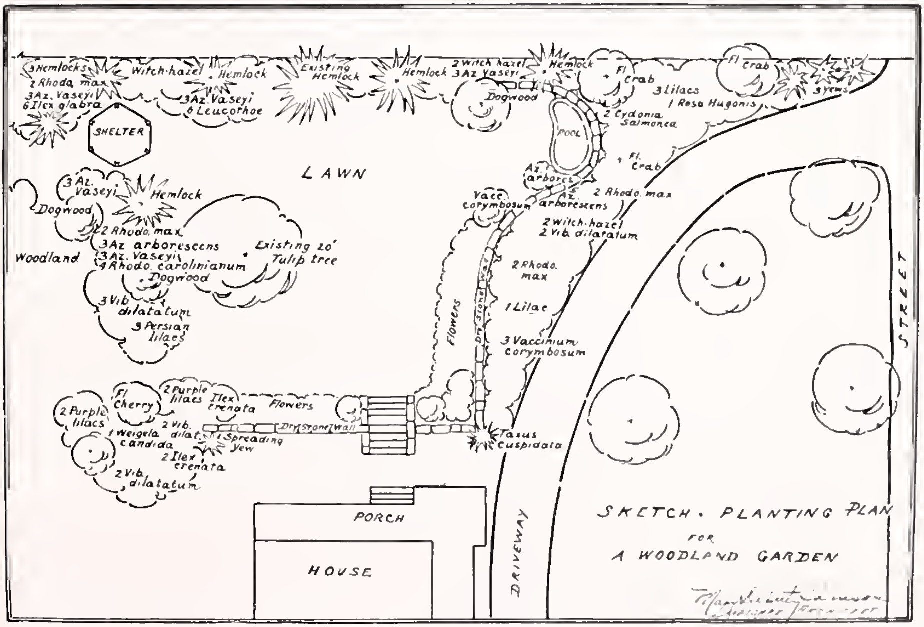
This garden is located in a suburb of New York City on a wooded property. A very large house is set 50 feet from the street and the entire property slopes down from the street to a valley well behind the house. The owner wanted a small flower garden just north of the house and below the driveway. In order to level the area, a dry wall was built on the east side of the garden, of the native brown stone. It is irregular in shape and the curve of the wall encloses a small pool with native stone set up for the coping. The house casts some shade in the garden area and a very large tree in the center determined the final grade of the garden and also the rather shady character of the planting.

Immediately north of the garden is another large house which had to be screened by heavy planting along the property line. To the west of the garden is a natural woodland and beyond it the vegetable garden. In spite of the fact that the area is so close to the road and between two large houses, it had a woodsy atmosphere and both the informal design and the plant material were planned to carry out this feeling.

Between the dry wall and the driveway were two fine large rhododendrons and a few other shrubs whose age and condition made them fit only for the refuse heap. As the rhododendrons were crowded and one of them was almost on top of the dry wall, they had to be moved and other planting was added to give a lighter texture and other seasons of bloom. On the sunny north end of this planting, flowering crabs helped to screen the street and the neighbor's property and bloom with purple and white hybrid lilacs. Near the rhododendrons, facing down this planting above the wall, are the pink and white *Rhododendron* (*Azalea*) *arborescens*, the earlier *Rhododendron* (*Azalea*) *Vaseyi*, the salmon pink flowering quince, *Chaenomeles* (*Cydonia*) *"Corallina."* Two more *Rhododendron maximum*, the American witch-hazel (*Hamamelis virginiana*), a linden viburnum (*Viburnum dilatatum*) were used for height and fall color in this planting. This completely screens the garden from both the driveway and the public road. It also increases the apparent size as the azalea and rhododendrons bloom with the tulips and irises on the lower level at the big garden season in May and early June.

At the north side of the garden a dogwood overhangs the pool and also helps to screen the street. As the area that could be given to planting here was very narrow, large size hemlocks, witch-hazel, the viburnum and azalea were used and spring bulbs naturalized under them to extend the bloom season to the back of the garden.

Opposite the pool is a small hexagonal shelter which has seats on the two sides but is open on the front and back leading to a woodland path down the hill. On the west side of the garden tall shrubs, such as rhododendrons, witch-hazel, and azalea, enclose the garden and flourish even in the shade of the big tree, and at the end of the dry wall nearest the house the bloom of purple lilacs and white weigela carry the garden feeling to the upper level. The actual flower beds in the garden occupy only 200 square feet and are



planted with perennials to give bloom from May through September. A few old-fashioned annuals, such as petunias and zinnias and blue salvia, follow the tulips and the foxgloves and Canterbury bells so that the beds are bright with color throughout the summer while the rest of the garden is pleasantly green and cool looking. The garden is a very good example of the fact that size and the area of actual flower beds has very little to do with the illusion of being in a real flower garden. Designed to take advantage of existing assets like the big tree and the woods beyond and to turn liabilities of shade and difficult grading into assets, the garden is one that can be enjoyed either from the higher level of the house or sitting in the shelter in the garden.

* * *

WHAT'S IN A NAME?

Discussing the why and wherefore of plant names.

H. K. Svenson

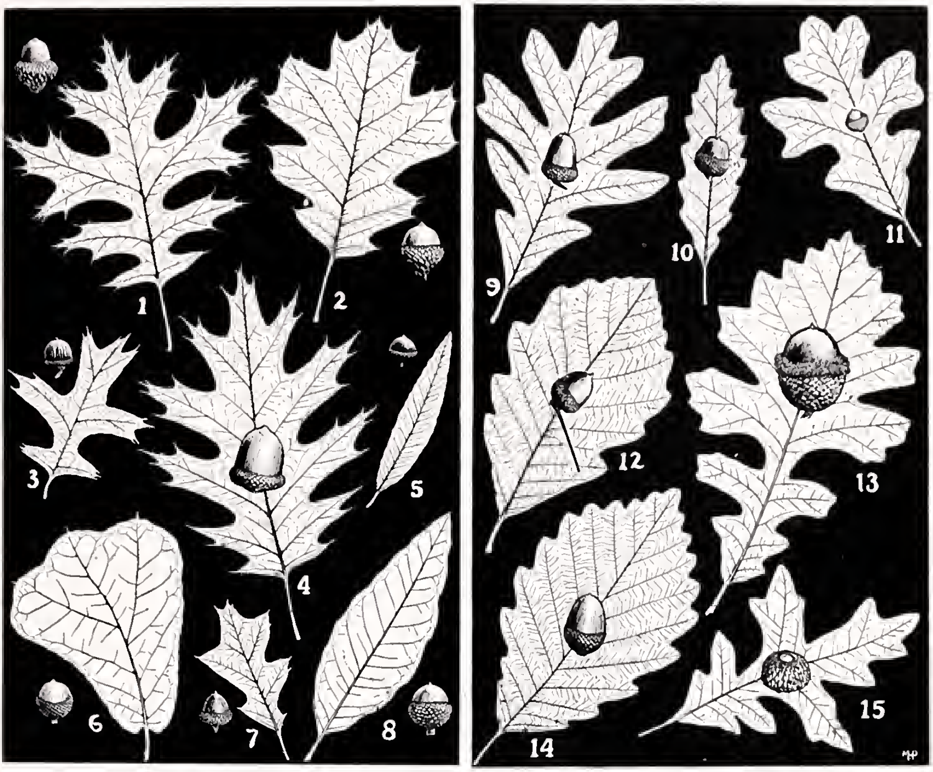
THERE are some 200,000 species of flowering plants in the world and many of these have several varieties, also with names. Thousands of horticultural or garden varieties have fancy names, in addition, such as the various oriental designations for flowering cherries or crab apples; and roses and iris often have names of distinguished persons associated with them.

A common name does not always have the same connotation everywhere. The name "woodbine" or "woodbind" means different things to persons in the northern and southern United States; and something else again in England.

Then there is the common mountain laurel of the northern states, which in the southern mountains is most frequently called "ivy," the name "laurel" being reserved for the rhododendron (*Rhododendron maximum*). So it should not have been surprising—though I admit it was to me—when I was asked one day in the oak barrens of Tennessee if I would like to see a bush of poison ivy: "It ain't so common here in the bar'ns, but there's plenty of it up on the mountain." Of course the "poison ivy" was mountain laurel (*Kalmia latifolia*) which is poisonous to livestock. Now we are accustomed to calling a creeping shrub, having leaves with three shiny leaflets, "poison ivy," and this plant is known technically as *Rhus Toxicodendron*. In the South, this same plant is called "poison oak." In connection with livestock it may be pointed out that the small laurel, *Kalmia angustifolia*, is called "lambkill" in the North; in the South it is known as "wicky."

Technical Names Needed for Precision

It will have become evident to the reader that whenever precision is to be obtained a technical name must be employed. These are compounded from Latin or Greek or both, and are "binomial," that is, each technical name is composed of two words: first, a genus name, e.g. *Quercus*, which includes all the oaks, and second, a specific name, e.g. *Quercus palustris*, which means a specific kind of oak. Some genera have very few species. In others they may be very numerous, as in the genus *Solanum*—to which the white potato, eggplant, and Jerusalem cherry belong—which has about 1500 species.



Oaks all belong in the genus *Quercus.* Leaves and acorns of fifteen different oaks designated with *specific* names as follows: 1. *Quercus coccinea.* 2. *Q. velutina.* 3. *Q. palustris.* 4. *Q. rubra.* 5. *Q. Phellos.* 6. *Q. marilandica.* 7. *Q. ilicifolia.* 8. *Q. imbricaria.* 9. *Q. alba.* 10. *Q. prinoides.* 11. *Q. stellata.* 12. *Q. bicolor.* 13. *Q. macrocarpa.* 14. *Q. montana.* 15. *Q. lyrata.*

Our binomial nomenclature begins with Linnaeus' "Species Plantarum," published in 1753, in which these simplified binary names were set up as accessory to the polynomial species names used in that work. In themselves they are usually descriptive, giving us a clue to the characters of the plants. The generic name is often of Greek origin, and reflects the ease of the Greek language in formation of compound words. The second word or specific name is most frequently a Latin adjective, descriptive or geographical; or it may be a substantive noun, representing an old genus name of earlier usage. Personal names and substantives are capitalized; all other second names begin with a small letter. Where great precision of technical names may be required, chiefly in discussions which deal with their bibliographic history, it is often necessary to cite the author of a name or even its place of publication. But this procedure is rarely desirable in horticultural writings.

Scientific Names Full of Meaning

The ease with which Greek words form compounds is seen in such common terms as "telephone," "xylophone," and "thermometer"—so it is not surprising that analogous combinations have come into use for names of plants and animals.

Thus we have *Zanthóxylum,* meaning "yellow wood"; *Acanthopánax,* which means "spiny panacea," since the ginseng (*Panax*) was thought to be a cure-all by the Chinese; *Pyracántha,* a spiny pear; *Cercidiphýllum,* which has leaves resembling those of the red-bud or Judas-tree, *Cercis,* on a species of which Judas was supposed to have hanged himself; *Cotoneáster,* meaning an inferior quince, since the leaves in some species resemble leaves of quince (Greek: kotoneon). One might think that the Greek word "kotoneon" would have gone down as the name of our common quince. But this is not so, for *Cydonia,* the technical name of the common quince, comes from Cydon, a name for the island of Crete where fine quinces were grown in early times. One of the shrubs mentioned in the article, "Shrubs for Special Uses," has the name *Chaenomeles* (kee-no-mée-lees), the flowering quince. This red-flowered shrub with exceedingly hard fruit was formerly placed in the genus *Cydonia* and will be so found in older catalogues. Most modern books such as Bailey's "Manual of Cultivated Plants" and Rehder's "Manual of Cultivated Trees and Shrubs" separate the genus out from *Cydonia* as *Chaenomeles.* This latter name means "split apple" or "melon" since the fruit was supposed to have split into five parts. The word "meles" is the same as our word "melon" and suggests that the Greeks did not have a differentiating word for apples and melons. The orange did not come into the Mediterranean area until much later, so that the "golden apples" of Greek mythology remain somewhat of a mystery. *Chamaecyparis,* or "ground cypress," is another Greek compound, our native species of the New Jersey coast being *C. thyoides,* i.e. resembling the arbor vitae (*Thuja*).

How They Originate

Many names of trees and shrubs are of Latin origin, such as *Juniperus* (juniper), from which the word "gin" (flavored by juniper berries) is ultimately derived. Another Latin name is *Larix,* from which we have the name "larch," though the native American names "tamarack" and "hackmatack" are common in some localities.

One of the few Japanese scientific names is *Tsuga,* the hemlock, and our species of eastern United States is known as *Tsuga canadensis.* Hemlocks, spruces, and firs were all included under the pines (*Pinus*) by Linnaeus, and it was not until 1855 that Carrière set apart the genus *Tsuga.* In changing over, or splitting off a genus, as for example the genus *Tsuga* from *Pinus,* a new combination of names has been made and the full bibliographic citation would be *Tsuga* (L.) Carrière, the earlier author being cited in parentheses. This method tends to keep straight the exceedingly complicated bookkeeping that is involved in the historical treatment of botanical names. In Loudon's "Arboretum," vol. 4, p. 2322, 1854, the American tree is called "Hemlock spruce fir," and it was known as "hemlock spruce" by the early settlers in America. The origin of the words "hemlock" and "spruce" is interesting. The term "hemlock" undoubtedly refers to the lacy foliage, resembling the cut leafage of the poison hemlock (*Cicuta virosa*), a member of the carrot family (*Umbelliferae*), by which the tree was distinguished from the Norway spruce (*Picea excelsa*), abundantly planted as an ornamental. The Norway spruce, not native in England, received its common name from the large amount of timber imported from Norway into England. Another common name in Europe was "Prussian fir," from which the name "spruce"—cf. "prussic" or "proosic" acid—is derived.

Many generic names come from the names of botanists or other personages. Thus *Kalmia* comes from Per (or Peter) Kalm, one of Linnaeus' students who visited America in 1742, and whose two volumes of "Travels" form one of the most readable accounts of life in the Colonies. *Gardenia* takes its name from an English physician, Alexander Garden, who settled in Charleston, South Carolina. *Wisteria* or *Wistaria* was named for Caspar Wistar of Philadelphia; *Magnolia*, from Pierre Magnol, a seventeenth century botanist at Montpellier. One of the most interesting cases is that of *Lespedeza*, which originates from Cespedes, one of the Spanish governors of Florida. There was evidently some misunderstanding of the initial letter of the name, or else the difficulty of translating the Spanish sound of the letter "C" into Latin was too much. At any rate, the original spelling is to remain, just as in *Wisteria*.

What Is a Variety?

With some 200,000 species of flowering plants already described, it is just as well that we have the subdivision "variety" available for the rank below "species." The term "species," by the way, is both singular and plural. "Specie," as one botanist has said, "is what other people have in their pockets." Having just unsuccessfully asked some intelligent people what "specie" is, I may state that it is gold or silver coin, and that the term is a heading on all bank-deposit slips. In strictly botanical literature the term "var." should precede the varietal name, as in *Rosa rugosa* var. *plena*, but in horticultural literature the "var." is more frequently omitted.

Common names of plants, which may antedate Linnaean publications, sometimes remain as a source of confusion. About the year 1600 there was in Europe a "blue syringa," for which we now use the Arabic name "lilac"; and a "white syringa," the shrub now called "syringa" or "mock orange." Linnaeus in 1753 chose *Syringa* as the technical name of the lilac, and our common lilac is known as *Syringa vulgaris*. The mock orange, accordingly, received from Linnaeus the scientific name of *Philadelphus*. Thus we have a situation where a common and technical name are identical, but represent two entirely different plants.

Manufacturing "Common" Names

From time to time attempts are made by bookish people to coin common names for plants. These are often merely English translations of the Latin in the scientific name, and one gets such monstrosities as the "glutinous anticlea" or the "white-edged sedge." Certain difficulties are encountered in this method. For example, *Pedicularis*, the lousewort or wood-betony, is a large genus of northern Europe and Asia, and *Pedicularis sylvatica* was long supposed to breed lice on sheep. In eastern America there are a number of species of *Pedicularis*. In one of our standard books we have a series of common names: marsh lousewort, swamp lousewort, etc.; but when we come to a beautiful species discovered by Kate Furbish in northern Maine, the common name quite obviously becomes "Miss Furbish's Pedicularis."

When English settlers came into the West Indies, they corrupted the name "bois fidèle" of the French into "fiddle-wood." Despite the well-known story that Nero fiddled while Rome burned, the violin was not invented until the sixteenth century. The nearest approach, in Greek, to the fiddle seems to have been the "zither" so the "bois fidèle" became "fiddle-wood" and then *Citharexylum*, quite an important genus of trees in tropical America.

The blue ribbon for common names, however, goes to "welcome-home-husband-be-you-ever-so-drunk," an old English name for *Euphorbia Cyparissias*. The drunkard association is thought to have been derived by someone from *Cyparissias*, i.e. "sip ere ye see us"—which is perhaps stretching things a bit too far. A frequently used common name for this plant is "cypress spurge"—a much more logical term coming directly from the species name *Cyparissias*, since the leaves are supposed to resemble those of the cypress tree.

Pronunciation

Scientific names are generally pronounced in this country according to the English method of pronouncing Latin, with the long sound of the vowels: thus "*glabra*" is pronounced "glay′-bra" and "*cordata*" is "cor-day′-ta" and "*purpurea*" is "pur-pew′-rea." On the other hand "*palustris*" is pronounced "pa-luss′-tris" and not "pa-loos′-tris," as one frequently hears it said. It may be argued that Latin nomenclature should be pronounced the way that Latin is taught in the schools, but that is no argument. Fads of pronunciation have their sway even in the dead languages. And scientific nomenclature is a sort of "hog Latin" that grew up through the Middle Ages—a language of its own that is not amenable to all the niceties of classical Latin and Greek. Thus, none of us say "klee′-ma-tis" (*Clematis*) or "an-e-mow′-ne" (*Anemone*) or "glad-i′-o-lus," I hope. (This last-named pronunciation, I understand, is wrong anyway.) In other European countries, the pronunciation of scientific Latin tends to conform somewhat to the peculiarity of the indigenous language. All attempts to make spelling and pronunciation conform exactly to classical procedure have ended in failure. And there remains a good deal of diversity among professional botanists in the pronouncing of scientific names—a situation which the amateur will accept with some glee.

Genera and species are built up on the judgment of man, and the judgment of man is not always trustworthy. Writers of books—even standard botanical references—are not invariably blessed with common sense, and there have been many changes in scientific names which were quite unnecessary. We all look forward to simplification and stability of plant names for the years to come. It must be admitted that there is some confusion in the use of scientific names but, even so, these are vastly preferable to the common or vernacular names. Not only are the scientific names comparatively uniform throughout this country, but they have universal application and can be readily understood throughout the world.

Technical names are not too difficult for the layman and often improve on acquaintance. Nearly everyone, except the inebriated, can say *Chrysanthemum* and *Rhododendron*—Greek compounds meaning golden flower and rose tree respectively. There are thousands of other scientific plant names which are equally euphonious and full of meaning.

* * *

YOUR NURSERYMAN AND YOU

How to Buy Living Plants

When possible buy them direct from a nursery. You are then much more certain of getting fresh stock, true to name.

Do not ask the nurseryman to spend too much time with you during April and May unless you plan to give him a sizeable order. This is his busy season when he needs your consideration.

THE LIVING TREE

A discussion of the parts of a plant: What they are and do.

Arthur H. Graves

LET us start with the proposition that any tree is a plant—one of the great group of flowering or seed plants that are now dominant on the earth, just as the mammals are the dominant group among the animals. This proposition scarcely needs proof, for it is a matter of common knowledge that in its growth and development and in its sexual life a tree is not essentially different from any other flowering plant, such as a daisy, violet, or buttercup, except in the fact that its stem, called the trunk, and its branches, as also its roots, are *woody* and therefore perennial, that is, lasting *through the years.*

And, since this number of PLANTS & GARDENS is devoted especially to shrubs, it should be stated that what we have to say about trees applies equally well to shrubs. Both come under the general heading of "woody plants." A "tree" has been described as a woody plant "having one well-defined stem and a more or less definitely formed crown, and attaining a height of at least eight feet and a diameter of not less than two inches." This is of course an entirely arbitrary definition. The truth of the matter seems to be that a tree is a woody plant with *typically* a single main trunk which attains a considerable height, while a shrub has many more or less erect stems all arising from one root system and not of any considerable height; e.g., lilac, privet, etc. There are some trees, such as the gray birch (*Betula populifolia*), and some of the large tree willows, whose trunks customarily grow in clumps, arising from a single base. The considerable height and girth of these, however, precludes their being classed as shrubs.

As in all flowering plants, the organs of the tree or shrub may be divided into two groups: 1) *the vegetative organs,* that is, the organs having to do with growth, nutrition, assimilation, etc. and 2) *the reproductive organs,* those whose functions are related to reproduction. We are not at present concerned with the latter group, which will be discussed in a later issue of PLANTS & GARDENS.

The vegetative organs may be divided into two classes: shoot and root. The "shoot" is composed of the stem and all its branches, and includes the leaves, the whole being known as the "shoot system"; while under the heading of the "root" are included the main root and all its branches, termed the "root system."

In order to understand fully the functions of the vegetative organs, i.e., what they do, we should get a clear picture of their environments and also a general idea of their structure.

The environments of shoot and root are very different. Air, the environment of the shoot, is a gaseous medium, of light weight, and transparent, allowing light to pass through it; while soil, the environment of the root, is a solid, though more or less porous, comparatively heavy, opaque medium. Thus roots ordinarily spend their life in complete darkness. Air is a mixture of gases—generally speaking, about ⅕ oxygen and about ⅘ nitrogen, plus a very small amount of carbon dioxide (from three to four parts in every 10,000 parts of air) and minute amounts of rare gases. Most air contains more or less water vapor, that is, water in the form of a gas, and, according to the season or weather, dust particles and various accidental minute objects, such as pollen grains, tiny seeds, etc.

The oxygen is essential for respiration; the carbon dioxide, although present in

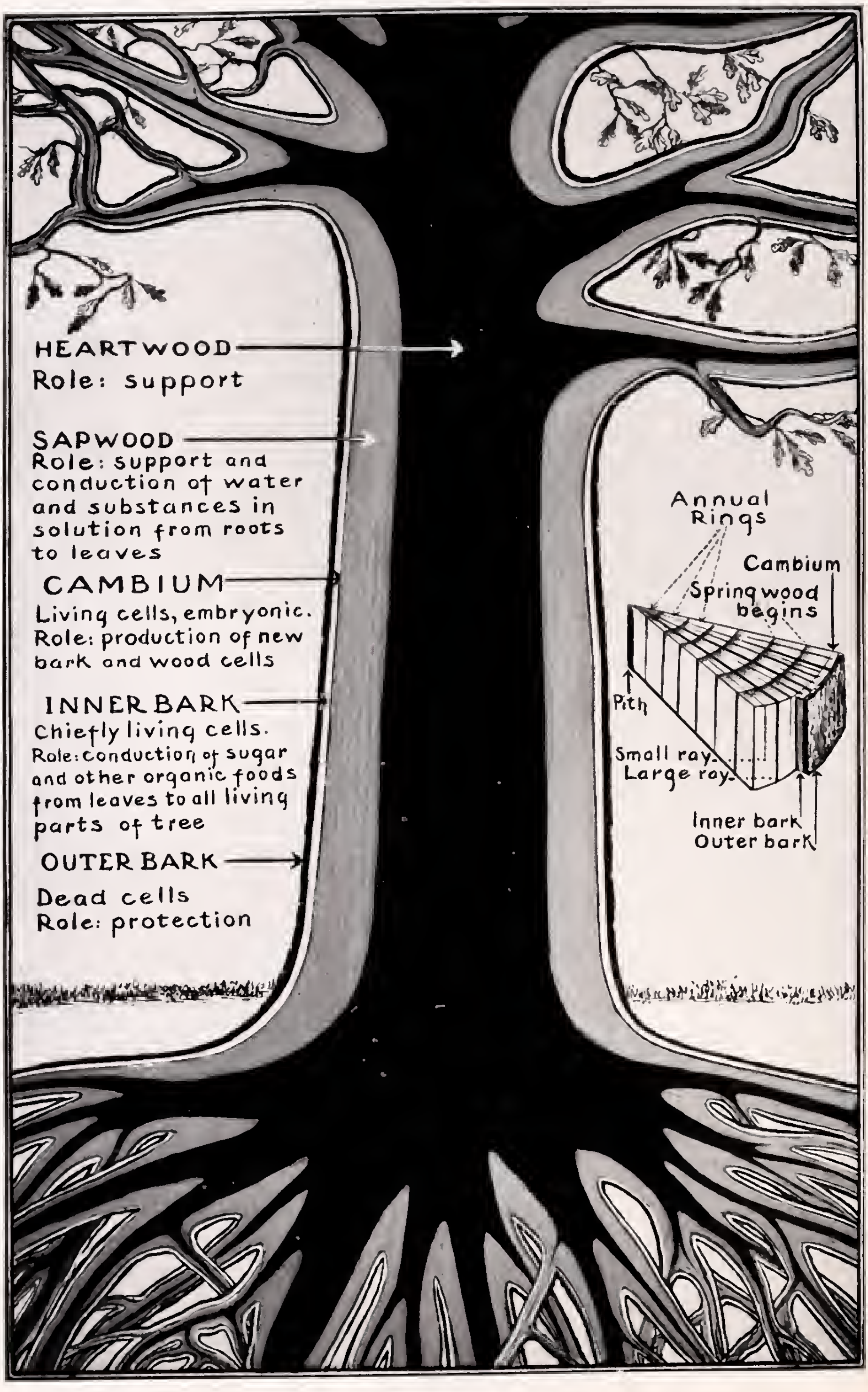

HEARTWOOD
Role: support
SAPWOOD
Role: support and conduction of water and substances in solution from roots to leaves
CAMBIUM
Living cells, embryonic.
Role: production of new bark and wood cells
INNER BARK
Chiefly living cells.
Role: conduction of sugar and other organic foods from leaves to all living parts of tree
OUTER BARK
Dead cells
Role: protection
Annual Rings
Cambium
Spring wood begins
Pith
Small ray
Large ray
Inner bark
Outer bark

FIG. 1. Diagram of a tree

such slight amount, is sufficient for the making of sugar; and the nitrogen, constituting nearly 80 per cent of the air, is a great diluting agent with which the essential gases are mingled. Except for certain bacteria, which convert the nitrogen of the air in the soil into nitrites and nitrates, no plant can use nitrogen in gaseous form.

The soil is composed fundamentally of more or less tiny particles of rock, and since these particles are usually somewhat irregular in shape and size, they do not fit closely together. Therefore, depending upon their nature, air spaces of greater or less size are interspersed between them, causing the soil to be more or less porous. Such air spaces are lined with thin films of water which adhere to the soil particles. Moreover this water is not chemically pure water (i.e. pure H_2O) but contains varying amounts of mineral solutions such as those containing sulphur, nitrogen, phosphorus, potassium, iron, calcium, magnesium, etc. derived mainly from the soil particles themselves.

In addition, soil which is fertile, that is, good for plant growth, should contain a certain amount of decaying organic matter to form humus. This is supplied by animal manure, dead leaves, or other remains or excretions of animal or plant bodies. Such organic matter is valuable for several reasons, the most important of which are: 1) it adds valuable chemical elements to the mineral solutions of the soil water; 2) it lightens the soil, making it more porous and thus easier for roots and root hairs to penetrate, giving them a readier access to the "soil atmosphere," and so to oxygen for respiration; 3) it holds moisture readily, thus increasing the water-holding capacity of the soil as a whole; 4) it contains bacteria which by their chemical action render the minerals and other substances (especially nitrogen) more readily available in solution.

Growth. In order to set forth clearly the way in which the vegetative organs are adapted to their environments, let us first examine the manner of growth of these organs. In the higher animals, as is generally understood, growth occurs more or less simultaneously throughout the individual—at least there are generally no localized regions of growth. But in woody plants the growth occurs in three main regions: 1) at the ends of the stem and its branches; 2) at the cambium, and 3) near the ends of the main root and its branches. Thus the young regions of the tree are at or near the ends of the stem and near the tips of the roots, also near the cambium of the stem. In our latitude, in the growing season, from April to midsummer (or later, in the case of roots), cells are constantly growing and dividing, making new tissues in this way.

The cambium is a cylinder of growing and dividing cells located between the bark and the wood. By its activity the tree increases in thickness or girth year by year. The cambium extends throughout the tree, in roots, trunk, branches—even to the smallest ultimate twigs.

Let us take the cambium as an example of the way growth and cell division take place. (Fig. 2.) Each cell increases in size and divides into 2 parts (2, 3). Perhaps the inner part becomes a "permanent" cell and is known as a "wood" cell (3). The process may then be repeated (4), another wood cell being

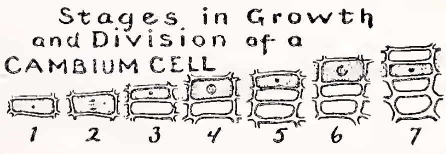


Fig. 2. Redrawn from Curtis' "Nature and Development of Plants." Fig. 44, Page 82. Seventh edition. 1918. By permission of Henry Holt & Co.

1. Resting cell. 2. Dividing cell. 3. Inner cell becomes wood cell. 4. Cambium cell again dividing. 5. A second wood cell formed as a result of this division. 6. Cambium cell again dividing. 7. Outer product of this division becomes bark cell.

formed (5). Next, the outer cell may become permanent, becoming a cell of the "bark" (6, 7). The process is usually not as simple as this, since often there are further divisions before the cells become permanent. Also, as shown in the figure, there are usually more wood cells formed than bark cells. Because the cell cavities of the spring wood may be large, and are often tubular, known as "pores" or "ducts," the contrast between these and the thicker-walled cells formed toward the end of the last season's growth (summer wood) makes an apparent ring which is called the "annual ring." (Fig. 1, inset.) This term is properly applied only to the whole woody tissue made in a single year.

Another cambium, the cork cambium, forms very early in the life of the tree just underneath the surface of the main stem and its branches. This cambium forms cork or cork-like cells which soon become dead and impervious to water and are cast off toward the exterior of the stem or trunk. This cambium, cutting deeper and deeper into the bark as the trunk increases in girth, brings about, in a manner characteristic for each species, the sloughing of the outer layers of the outer bark. The outer bark, which is dead and dark-colored, serves to protect the living inner bark and cambium from mechanical injury, from insect and animal attack and fungous disease, from sudden changes in temperature and from drying out.

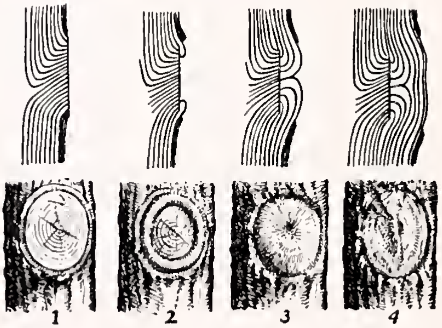


FIG. 3. Showing how cambium forms callus to cover pruning wound. 1. Newly made cut. 2. Callus one year old. 3. Four years old. 4. Eight years old.

A knowledge of the position and nature of the wood cambium is absolutely necessary for success in grafting work; for the most important part of this operation is to join the cambiums of both stock and scion, as will be shown in detail in a subsequent issue of PLANTS & GARDENS. The cambium is also important for the healing of wounds, that is, deep wounds which extend as far as the wood. When a tree is pruned it is the cambium that, by its growth year after year, at length covers over with new tissue the area which was the base of the pruned branch. (Fig. 3.)

The *growth in length* of the stem is accomplished by means of groups of cells (called "growing points") at the ends of the stem and its branches. During the growing season these cells continually grow and divide. Usually this growth in length is soon finished (in our latitude somewhere around July 1 in woody plants of "determinate" growth) but the growth in thickness by means of the cambiums of the stem and branches continues usually until some time in late summer, depending on the character of the season and the species of tree.

The *growth in length* of the roots is accomplished in a fashion similar to that of the stem, except that certain cells are pushed off in front of the root tips to form the root cap (Fig. 4). These protect the delicate young cells of the tip as the main root or its branches penetrate the soil. At the same time, as in the stem or trunk and branches, the roots back of the tip are growing in girth by means of a cambium like that of the stem.

The leaves are formed in woody plants in the buds which begin to appear in the leaf axils, i.e., points on the stem just above the base of each leaf stalk, about the middle of May, in our latitude, or soon after the leaves of the year unfold. In these tiny buds all the leaves (and also in many cases all the flowers) that will unfold the *succeeding* year are formed in miniature, and are folded closely together in a manner characteristic of the species, the whole bud being fully formed by the end of summer. There are no growing points in typical leaves: the tiny cells enlarge with fair rapidity during the unfolding of the bud to their mature size; but often only part of the leaf, usually the base, develops first.

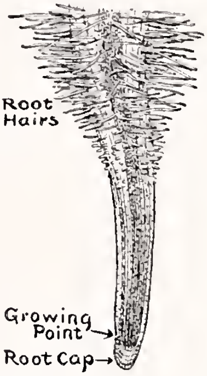


Fig. 4. Diagrammatic drawing of structure of typical root tip. After Ganong. Textbook of Botany for Colleges. Fig. 159, Page 216. 1917. By permission of the Macmillan Co.

Functions of the Vegetative Organs. How are the vegetative organs of the tree adapted to their environments and how do they perform their functions?

1. *The Root.* In its structure and form the root system shows well its adaptation to its soil environment. Only the tips of the roots, near the regions of active growth, serve as absorbers of the water and solutions in the soil. Most important for this purpose is a zone of root hairs (really tubular extensions of surface cells) which begins to appear a short distance back of the growing point, the hairs becoming longer and longer until they finally die off. (Fig. 4.) As the growing point and root cap advance in the soil, new hairs begin to appear, so that the root hair zone is of constant length. The root hairs serve to increase the amount of root surface available for absorption. It has been stated that the area of absorptive surface thus may be increased as much as 20-fold. It is on account of damage to these root hairs as well as to the younger parts of the root, so important for the life of the plant, that one must be careful, in transplanting, to injure these parts as little as possible, and, during the time between digging and resetting, keep them from drying by covering them with moist burlap, moss, shavings, soil, or something similar.

As with all living cells of the plant, the root hairs use oxygen for respiration. Hence, if necessary, we drain soils before planting, so that the interstices among the soil particles will have sufficient air for respiration. Without this air the root hairs and the root tips will grow very slowly, or gradually die; and the leaves, failing to get water and minerals for their growth and work, turn yellow and finally drop off. This is what often happens to house plants that are overwatered lovingly day after day until the soil is saturated with water so that the roots can no longer get air.

On the other hand, the larger roots and their branches function only for support and for conduction of liquids, as does the trunk or stem and its larger branches.

The branching of roots is irregular, their environment being of an entirely different nature from that of the shoot. When they encounter the necessary moisture or mineral solutions their development is greater, not, we believe, from any inherent attraction toward such a region, but because such environment furnishes greater nourishment, resulting in greater growth. Finally, the internal structure of the older roots is similar to that of the stem, with this difference, that it is of such a kind as to withstand torsion, to which the root, from the nature of its environment, may be subjected.

2. *The Stem.* Young trees or, as they are called, "seedlings" of a few years of age, show, typically, erect stems with the leaves borne at fairly regular intervals,

called nodes, the spaces between being called internodes. The leaves are borne on the stem either in a spiral fashion or opposite each other at the nodes, sometimes more than two at each node. When opposite, they occur in planes at right angles to each other in successive nodes. Such arrangements are adaptations to the light and air of the shoot environments.

The trunk is cylindrical, a form well suited to resist the action of winds. Furthermore, being compactly and strongly constructed, it is adapted for support of the numerous branches, and, increasing in girth year by year, it can also bear, each year, an increasing number of branches. It is evident that the trunk is constructed and the branches arranged in such a way that they give support to the leaves and display them to best advantage for access of light and air. Further, the sapwood conducts the water and solutions absorbed by the roots to the leaves, where these materials are used in the food-making process. The food (sugars and other organic foods) when formed is transported through the living or inner bark down to the growing roots and also to the buds and the cambium where it is used in building up new tissues.

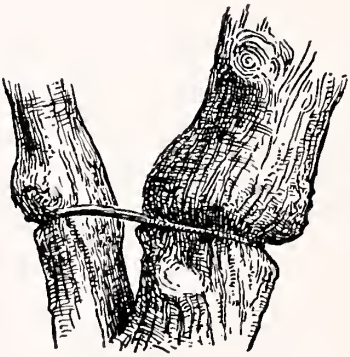


FIG. 5. The result of girdling by a metal band

Therefore, if we "girdle" a tree, i.e. cut out a ring of bark as far in as the wood, extending around the whole circumference of the stem, we interrupt the course of the food from leaves to roots, which, therefore, sooner or later die, causing the death of the whole tree. A similar cause and effect is produced by wires drawn tightly around a tree. In such a case, indeed, it is the growth of the wood cambium itself that makes the wire or band appear to sink deeper and deeper. (Fig. 5.) A vine spiralling around the trunk has a similar effect, except that here there is an opportunity for the tree to adjust its food translocation to the course of the vine.

Since this treatment results in a stoppage of food transport, and food accumulates *above* the girdle (as shown by the swelling located there) it is sometimes utilized horticulturally (known as "ringing") to bring about increased bearing or greater fruitfulness in the parts above the girdle. Thus it is sometimes a practice of grape growers to girdle the stem below the grape clusters and produce bunches of larger size in this way. But such girdling should not be done on the main stem, only on a side branch which will ultimately be pruned off anyway. By this method food made in leaves of the branch in question is prevented from going to other parts of the vine. The advantages are: 1) the fruit has a larger "set", i.e., more grapes ripen per bunch; 2) the grapes are larger; and 3) ripen earlier. Ringing is not uniformly productive of good results and should be practised only with caution, if at all.

For radial transfer of foods or watery solutions, rays, composed of cells elongated in a transverse direction, are interspersed here and there in the wood and inner bark. (Fig. 1.)

Only the outer rings of wood, i.e., those which are of newest "make," function to carry up the water and solutions known as the "sap." Hence they comprise the "sapwood." The older rings of wood lose their conducting capacity, their cells becoming plugged up and finally dying entirely. Meanwhile their walls often become infiltrated with gums or resins so that they are usually darker colored. They then form what is known as the heartwood and their only function is support. In some trees, such as white ash and spruce, the heartwood remains uncolored.

We sometimes find large old trees with hollow trunks, the heartwood having decayed (e.g. the Charter Oak), but a shell of living sapwood remains, so that the tree is apparently healthy. But if such a tree happens to stand in the path of a hurricane, we may say, "and it fell: and great was the fall of it."

One other function of the stem is to bear the flowers, i.e., the reproductive organs. These are usually borne only after the tree reaches a certain age and in the upper part of the tree, where they are easily accessible to wind or insects, the agents of cross pollination.

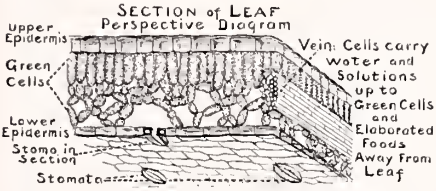


FIG. 6. From Sinnott's Botany: Principles and Problems. Fig. 38, Page 78. Second edition. 1929. By permission of McGraw-Hill Book Co., Inc.

3. *The Leaves.* The leaves are special organs adapted to the manufacture of organic food. Sugar is the first product formed; and later, chemical elements brought up in the sap from the roots are added to some of this sugar, forming proteins. These so-called "elaborated" foods are transported in soluble form through the inner bark to other portions of the tree.

In addition, the leaves perform the function of respiration, a process which, it is true, occurs in every living cell. Further, they are adapted to the giving off of surplus moisture in the form of vapor from the pores in their under surface—a process called transpiration. Finally through these same pores, called *stomata,* air is admitted to the interior of the leaf; and from this air carbon dioxide is absorbed, which is indispensable in the manufacture of sugar. (Fig. 6.)

The leaves, in shape, structure, and manner of orientation are well adapted to carry on all these functions.

Since they depend for their work on the presence of pure air, it is evident that poisonous gases such as illuminating gas (even in small amounts) and sulphur dioxide, commonly occurring in cities and within city dwellings, are more or less harmful according to the degree of impurity. Moreover, the excessively dry air common in house interiors during the winter season is particularly unwholesome. A thorough understanding of these harmful effects, and the ways in which they work, is essential for success in plant culture. In a later issue of PLANTS & GARDENS we shall have space to give in detail these reactions as well as to describe fully the structure and functions of the leaves themselves.

How to Buy Living Plants

If you have been in the habit of having your trees, shrubs and herbaceous perennials planted by your nurseryman try, this year, to plant them yourself in view of the shortage of labor.

SHRUBS FOR SPECIAL USES

Charles F. Doney

SHRUBS play an important part in any landscape or garden planting. The uses to which they are put are many. In boundary plantings and hedges they enclose a property, giving it individuality and the privacy that is desirable for the use and enjoyment of the garden areas. They serve as a background for herbaceous plantings; they soften and enhance architectural details, drawing attention to good features and away from awkward ones. And while doing all these things they create beauty and interest by their habit and flowers, fruit or foliage.

The selection of shrubs should be done deliberately and thoughtfully, for there are many factors to be taken into account; a pleasing and attractive planting is largely the result of the right plant in the right place. A consideration that is of prime importance, yet evidently often ignored is the ultimate height, spread and form of the shrub. Obviously it is useless to try to fit a plant with a spread of 6 feet into a space of 3 feet, and, by the same token, to use forest trees in foundation plantings.

It is important, too, to plan for a continuity of interest, derived from the presence of something attractive in the garden in each season, throughout the year. Flowers and fruits are the obvious attractions, but they are often transitory and therefore should not be the sole criterion. Shrubs with pleasing foliage are valued throughout the growing season and may be gorgeous in their fall coloring; while those with colored bark such as the red and yellow osier dogwoods, and those with striking and picturesque branch patterns can be effective in the winter.

The appropriateness of the shrub, that is, how it will fit in with the rest of the planting, must be considered. Density of growth, and color and texture of foliage play an important part in achieving the rather subtle quality of "rightness." A discriminating selection of shrubs can go a long way in redeeming a poor garden plan or in making up for no plan at all.

In the following pages various shrubs have been grouped in accordance with special purposes for which they are of value. Many of them, it will be noticed, appear in more than one list. It is hoped that by classifying them in this way you will be helped to choose just the shrub you may need to solve your particular planting problem.

Combined, the shrubs included here represent a selection of what we believe to be thoroughly worth while kinds, with their defects, if any, duly noted. Their descriptions, height, time of blooming and behavior in general are based on their performance here in Brooklyn, where the temperature seldom falls below zero. In general, one might expect them to thrive better and flower and fruit more profusely when planted in the cleaner air of the country.

A catalog such as this, and reference books, are useful in helping one choose the species and varieties to use. But it is better still to see the plants actually growing. This may be done by visiting nearby nurseries, many of which maintain display collections of mature specimens; or by visiting neighbors' gardens where one can often get ideas for effective combinations. If you want to see extensive collections of shrubby material we invite you to visit the Brooklyn Botanic Garden where you will always be welcome.

Rhododendron Schlippenbachii. A species of considerable charm despite its awkward name.

FOR ACID SOIL

Hydrogen ions predominate in acid soils, and soil testing outfits can tell us the relative amount of this excess. If hydrogen (H) and hydroxyl (OH) ions are present in equal amount, the soil is neutral—neither acid nor alkaline: if the hydroxyl ions are in excess, the soil is alkaline. Acidity and alkalinity are expressed numerically as values of pH. A pH of 7.0 indicates a neutral solution: higher numbers, alkalinity; lower, acidity.

One can not judge the acidity of a soil by appearances. An acid soil may appear sandy and sterile or, on the other hand, it may be rich and loamy, but with a high percentage of acid, humus-forming materials, such as peat moss or partly decayed oak leaves.

Most shrubs get along well in slightly alkaline, neutral or slightly acid soil; but a few, like most azaleas and rhododendrons, require an acid soil. Following are some of the more beautiful or useful shrubs which thrive in acid soil.

Calluna vulgaris, Heather. The low, evergreen shrub that is so abundant on the moors of England and Scotland. It varies in height from a few inches to 2 ft. or more, and the tiny, scale-like leaves are arranged in 4 rows which make the stems appear square. For several weeks in the summer the plants are covered with small purple-pink flowers. It is excellent for massing on sunny slopes in sandy and peaty soil. Unfortunately under cultivation it may grow well for a while and then peter out. There are several varieties:

var. *carnea.* Flowers pink.

var. *Hammondii.* Bright green leaves and white flowers.

Enkianthus campanulatus. A tall, somewhat columnar shrub to 8 or 10 ft. or more. In May the plants are attractive with their pendulous clusters of bell-shaped yellow flowers that are tinged with red, and in the fall the foliage colors brightly—one of the chief reasons for planting it. This is an uncommon but very good subject suitable to refined plantings in sun or partial shade and, preferably, moist soil.

E. perulatus is slow-growing and twiggy, ultimately attaining a height of about 6 ft., with white flowers in late April. It is more compact than the preceding species and can be used in smaller plantings.

Erica carnea, Spring Heath. A low evergreen of limited garden value but it has possibilities in the rock garden. It

Enkianthus campanulatus. Tall and symmetrical with yellow, red-tinged flowers and bright autumn foliage.

reaches 12 to 18 in. in height and has short, needle-like leaves. The small rosy flowers open in late March or early April. It grows under the same conditions as heather and, similarly, needs an occasional shearing.

Leucothoë Catesbaei, Leucothoë. An evergreen shrub with gracefully arching branches and lustrous green leaves that turn red or bronze in the fall. It varies between 3 to 6 ft. in height and in April the branches are strung with pendulous spikes of fragrant, white bell-shaped flowers. Best growth is made in partial shade and moist peaty soil. It is useful in foundation plantings, for "facing down" rhododendrons, and as undergrowth in naturalistic plantings.

Rhododendron calendulaceum, Flame Azalea. A native shrub sometimes growing to 10 ft. in height but usually less. Its flowers are gorgeously colorful, varying from yellow to orange, scarlet and red. Because of the brilliance of the flowers this azalea is best planted in groups by itself.

R. carolinianum, Carolina Rhododendron. As its name implies the home of this charming evergreen is in the mountains of North Carolina. At times it is tall and straggling in habit but under good growing conditions it is fairly compact and varies between 4 and 6 ft. in height. It has pleasing pink flowers in May and will thrive in sun or shade. It can be used in foundation plantings and low evergreen groups.

R. catawbiense, Catawba Rhododendron. Another shrub of exceptional beauty from the southeastern states. It forms a compact, rounded mass of 6 ft. or more, with oblong leaves about 5 in. long and clusters of lilac-purple flowers in late May. It is hardy and tolerant and makes its best growth in shade. There are many hybrid forms of better color.

var. *atrosanguineum.* Flowers red.

var. *Boule de Neige*. Flowers white; low and broad in habit.

var. *Mrs. Charles Sargent*. Flowers deep rose.

R. japonicum, Japanese Azalea. Another azalea with spectacular bloom, growing to 6 ft. or more, with upright branches and glowing clusters of large flowers in May that have the same color range, yellow to red, as the flame azalea. It is a hardy, easily grown species, outstanding for the vivid color of its flowers.

R. maximum, Rosebay Rhododendron. When growing naturally in moist, shaded regions this species sometimes exceeds 30 ft. in height and may be tree-like, but under cultivation we usually see it from 8 to 15 ft. It has rather large, oblong, pointed leaves and clusters of pale to purple-pink flowers in late June. In bloom and in habit it is inferior to the Catawba rhododendron, but it makes a splendid tall evergreen screen or underplanting in shaded or woodsy places where, however, it is a shy bloomer.

R. molle, Chinese Azalea. Spreading and rounded in habit it may eventually become 6 ft. high. The large clusters of glowing flowers of the species are typically golden yellow but it is probably better known in its many varieties and hybrids that have flowers ranging from yellow through shades and combinations of orange and red. A slow-growing azalea but tolerant, satisfactory and very showy.

R. mucronatum (ledifolium) (indicum album), Snow Azalea. A charming shrub with persistent or semi-evergreen leaves and of low, spreading habit—specimens 20 years old sometimes do not exceed 4 or 5 ft. in height and width. In May the plants are almost completely covered with large, broad white flowers. It is a good species for refined and dignified plantings.

var. *amethystinum*. Flowers rosy-purple, spotted with pink.

var. *Sekidera*. Flowers white, upper lobes spotted with rose.

R. mucronulatum (dauricum var. **m.),** the Korean Azalea, is a slender, more or less upright shrub to about 6 ft. Very early flowering, its bell-shaped, rosy-purple flowers are conspicuous in late March or early April. They remain in good condition longer if the plants are sheltered from the wind. The foliage turns dull red in autumn.

R. obtusum. A compact dense shrub with small, dark green leaves and abundant red flowers. While handsome in itself it is now represented in our gardens mainly by its varieties:

var. *amoenum*. Compact and slow growing, with small, persistent leaves and freely-borne, small, semi-double magenta flowers. It is best used by itself, for the color does not blend well. The leaves turn bronze in fall.

var. *Hinodegiri*. Compact in habit and slow-growing with somewhat horizontal branches and persistent dark green leaves. In May the plants are completely covered by the glowing crimson flowers; while the color is much better than that of var.

Rhododendron mucronulatum. The first azalea to bloom in the spring.

amoenum, it too is best used with white or by itself with an evergreen background. Even after 20 years of growth the plants may be less than 6 ft. high.

var. *Kaempferi,* TORCH AZALEA. More upright than the preceding varieties and growing to 6 ft. and more, but not so compact in habit. In May the branches are crowded with salmon-red or pink flowers. It is a very good variety but is best planted in partial shade, for the flowers fade and scorch quickly in strong sunlight.

R. roseum. An American azalea with fragrant, bright pink flowers in May. It is easily cultivated, growing well in sun or partial shade, and is more tolerant of alkaline soil than most azaleas. It is suitable to informal and naturalistic plantings. The native pinxterbloom (*R. nudiflorum*) is very much like this species, but has paler pink flowers and blooms about 2 weeks earlier.

R. Schlippenbachii, ROYAL AZALEA. Despite its awkward name this is a distinct and very lovely species. Slow growing, although eventually reaching to 6 ft., it is often difficult to establish. In May it bears clusters of large flowers that vary from pale to deep pink with brown spots at the base of the upper lobes. As is true of most azaleas the flowers remain in good condition longer if in partial shade.

R. Vaseyi, PINKSHELL AZALEA. Though a native of North Carolina the pinkshell azalea has proved quite hardy in the northern states. It is a tall shrub of loose, irregular habit and bears small, rose-pink flowers in late April or early May before its leaves unfold. It is at home in naturalistic plantings.

R. yedoense (Azalea yodogawa) is a broad, low growing shrub, usually around 3 ft. in height with double flowers of rosy lilac in early spring.

var. *poukhanense.* Compact and low in habit, and in general like the type but with more pleasing single, rather than double flowers. It combines well with *Kerria.*

Other plants recommended for acid soil are: *Clethra alnifolia,* see "For Wet Soil"; *Ilex verticillata,* see "With Showy Berries"; *Kalmia latifolia, Pieris floribunda, Pieris japonica,* see "For Shade"; and *Myrica pensylvanica,* see "For Seashore."

FOR WET SOIL

While the shrubs listed below are capable of growing in ordinary garden soil, they are especially valuable for planting in that wet spot which, for various reasons, it is not desirable to drain artificially.

Clethra alnifolia, SWEET PEPPERBUSH. When not in bloom there is little about this species to attract attention, but in July or August when bearing its fragrant white flowers it is handsome indeed. A more or less upright bush to around 6 ft., it thrives best in moist, semi-shaded situations.

Cornus alba var. *sibirica,* SIBERIAN DOGWOOD. Varying in height from 6 to 10 ft. this vigorous coarse shrub is frequently used in landscape work because of its easy growth and the bright red color of its young branches in winter. The flat clusters of white flowers are followed by white or blue-white berries. It will grow in sun or semi-shade and is best used in naturalistic plantings or large shrub borders. Prune severely in spring to stimulate the production of abundant young growth which is most highly colored in winter.

var. *argenteo-marginata.* Leaves edged with white.

Salix caprea, GOAT WILLOW, is a large shrub or small tree of upright habit growing to about 15 ft. in height, with rough gray leaves. The catkins, or "pussies," are large and attractive in early spring. It is not a permanent shrub for the wood is weak and subject to boring insects. Prune severely in early spring for long wands of pussies. Cut off during the winter, and with the ends placed in water they can easily be forced into bloom indoors.

S. discolor, PUSSY WILLOW, is the common pussy willow of the eastern states. It resembles *S. caprea* but is lower and broader in outline. Children delight in gathering the flowering branches in the spring.

S. Elaeagnos (incana). A distinct species whose long, narrow leaves, almost white on the undersurface, give the branches a feathery appearance. It is a large shrub, sometimes with a spread of more than 30 ft., or a small tree which makes a handsome specimen.

S. purpurea, var. *nana,* ARCTIC WILLOW, DWARF PURPLE WILLOW. Compact, with gray-green leaves and slender, upright branches that average about 4 ft. in height. It is a good plant for a low hedge.

Sambucus canadensis, AMERICAN ELDER. A shrub of fields and roadsides whose broad clusters of white flowers and purple-black fruits are familiar to all of us. Though handsome, growing to 15 ft. with arching branches and pinnate leaves, it is too coarse and suckers too freely for any purpose but naturalistic plantings. It is particularly at home along streams or in moist places. The fruits are used in making wine and pies.

var. *acutiloba.* Leaflets deeply cut.

Viburnum dentatum, ARROW-WOOD, is a native species frequently seen along country roads and in moist woodsy places. It has upright branches (6 to 10 ft.) and sharply toothed, dark green leaves. The flat clusters of white flowers are followed by blue-black fruit. It is at home in naturalistic plantings.

Other shrubs recommended are: *Aronia arbutifolia, Aronia melanocarpa, Myrica pensylvanica* and *Vaccinium corymbosum,* see "For Seashore"; *Hamamelis virginiana* and *Lindera Benzoin,* see "For Shade"; *Ilex verticillata* and *Viburnum trilobum,* see "With Showy Berries."

FOR SEASHORE

Salt spray is very injurious to the foliage of most trees and shrubs, particularly in the spring and early summer, and only a few can stand it. Even those shrubs which are native along the shore are sometimes injured by salt laden fogs at this season. The buffeting of cold winter winds is another limiting factor. Small plants establish themselves more readily than large ones; and if the material can be bought from a nursery in the neighborhood where the plants are already partially acclimated by exposure to the sea air—so much the better. In exposed places some sort of a windbreak will help them through the first few winters.

When acquiring material for seashore planting the first choice will be plants already growing in the area or in similar situations elsewhere. Following is a selection of shrubs of this nature, together with others which can endure seashore conditions.

Amelanchier oblongifolia, Seashore Shadblow. A many-branched, upright, clump-forming shrub, low and stunted if whipped by the ocean wind. Under good growing conditions it becomes a small tree that may reach 20 ft. in height. Growing wild on the dunes of Fire Island, N. Y., it bears nodding, lacy clusters of white flowers in early spring and the purple-red berries which follow are quite palatable.

Aronia arbutifolia, Red Chokeberry, is upright, of open habit, 5 to 8 ft. high with white flowers in May and glossy foliage that turns red in the fall. The showy red berries last well into the winter. It prefers moist soil and because of its loose growth it is best planted in informal masses. It is useful among other shrubs and in naturalistic plantings.

A. melanocarpa, Black Chokeberry. Smaller than the red chokeberry, growing usually to about 3 ft. with shiny black berries that soon fall, and deep red foliage in autumn. It will stand drier soil than the preceding species and is adapted to low mass plantings. The variety *elata* grows 6 to 10 ft. tall and is more attractive.

Baccharis halimifolia, Groundsel Bush. An upright shrub, growing about 6 ft. high, found along the seashore and in salt marshes. The small, white flowers are only mildly attractive but on the female plant the old flower clusters are made conspicuous by the numerous white bristles (pappus) that tip the seeds.

Ilex glabra, INKBERRY. A native, black-fruited holly of upright rounded habit, 6 to 10 ft. high, with small, glistening, dark evergreen leaves. Well grown plants are handsome, faintly suggestive of boxwood, but because of a tendency to loose, open growth inkberry is best used in informal or naturalistic plantings. It will grow in poor sandy soil, preferably moist.

I. verticillata, WINTERBERRY. A common inhabitant of swamps in this area is this tall, more or less upright shrub of 6 to 9 ft. It is planted mainly for its persistent bright red berries but, being dioecious like the preceding species, both male and female plants must be present to ensure fruiting. Although in the wild it is found most frequently in wet spots, it will thrive in the usual garden soil.

Myrica pensylvanica (carolinensis), BAYBERRY. A slow-growing, symmetrical shrub of 6 to 9 ft. with handsome, dark green, aromatic foliage. The flowers are inconspicuous but the female plants bear small waxy, gray berries that are decorative in winter. It will thrive in sterile sandy soil but is difficult to transplant successfully.

Prunus maritima, BEACH PLUM, has an irregular, often straggling habit and varies in height from a few feet to 8 or 10 ft. In spring the branches are sometimes solidly covered with attractive white flowers. In recent years considerable interest has been manifested in the possibility of greatly improving the beach plum as a fruit producer by propagating desirable forms found in the wild and by breeding. The foliage is lustrous and pleasing and the abundant fruit makes excellent jam and jelly. It grows naturally along the coast from Maine to Florida.

Rosa rugosa. A handsome and popular species with stout, densely prickly stems. It has thick, wrinkled bright green leaves and large, sweetly scented flowers which bloom over a long period and vary in color from magenta to white. The large, orange to red fruits are decorative and persistent. This rose seems particularly happy near the sea and is effective when planted in groups; or it may be used as a hedge.

Symphoricarpos orbiculatus (vulgaris), CORALBERRY. A freely suckering shrub, usually around 4 ft. in height but occasionally to 6 ft., with dark green lingering leaves. As in the snowberry the flowers are of little ornamental value but they are followed by abundant dense clusters of small purple-red berries. It is also useful for planting on slopes and will stand shade.

Rosa rugosa has a long period of bloom and attractive fruits

Tamarix odessana. Good for seashore planting.

Tamarix odessana, Tamarisk. Open and spreading in habit and varying in height from 10 to 15 ft. In June and during the summer it bears spiky clusters of tiny, deep pink flowers on growth of the current season. Like the other tamarisks it is best planted in groups of its own kind. Prune this species before growth starts in the spring.

Vaccinium corymbosum, Highbush Blueberry. Commonly found in swamps and wet places this blueberry has considerable landscape value. It forms a stiff bushy shrub to 6 ft. or more with attractive flowers and palatable fruit. Its habit is good and the handsome foliage colors brilliantly in the fall. It will grow in sun or partial shade.

Other plants recommended are: *Berberis Thunbergii, Ligustrum ovalifolium,* see "Hedge Plants"; *Clethra alnifolia* and *Viburnum dentatum,* see "For Wet Soil"; *Cytisus scoparius* and *Rhus aromatica,* see "For Light, Sandy Soil"; *Hibiscus syriacus, Hydrangea macrophylla* and *Rhodotypos scandens,* see "For City Conditions"; *Rosa Wichuraiana,* see "Ground Cover."

FOR LIGHT, SANDY SOIL

While most shrubs prefer reasonably good soil there are a few, fortunately, that will grow satisfactorily in poor soil without the use of fertilizers or manure.

Cytisus scoparius, Scotch Broom, grows to a height of 5 to 8 ft. with numerous upright and spreading, slender green stems and large golden flowers in May. While useful in naturalistic planting in poor, sandy soil, it is not thoroughly hardy, does not transplant readily, and becomes scrawny with age.

Lespedeza bicolor, Bushclover. Growing naturally, this bushclover forms a slender shrub 10 to 12 ft. high. In this climate, however, it is more satisfactory when cut to the ground each spring, in which case it will throw up numerous stems that will form a rounded mass bearing abundant small red flowers in September.

L. Thunbergii (formosa). Thrives under the same treatment as the preceding species but in the fall the darker foliaged branches arch over under the weight of the myriads of small flowers, giving a graceful and informal effect. Both species grow well in full sun and light soil.

Rhus aromatica (canadensis), Fragrant Sumac. A spreading, suckering shrub variable in habit and forming prostrate tangles of branches, some plants sending up erect growth to 3 ft. while others grow to about 6 ft. The hairy leaves are fragrant and color brightly in the fall. In early spring the small clusters of yellow flowers are of mild interest and they are followed by hairy red fruits. It can be used as rough ground cover in dry soil on banks, etc. or massed along driveways.

R. typhina var. *laciniata.* A variety of the common staghorn sumac with handsome, deeply cut leaves. It grows in poor, gravelly soil and makes a brilliant display when the foliage turns orange to scarlet in the fall.

Robinia fertilis is tall and untidy, with bristly branches to 9 ft. which bear attractive clusters of rose-pink flowers in May; the flowers are followed by decorative bristly red pods. Because of its suckering habit it is best suited to wild areas where it can spread freely.

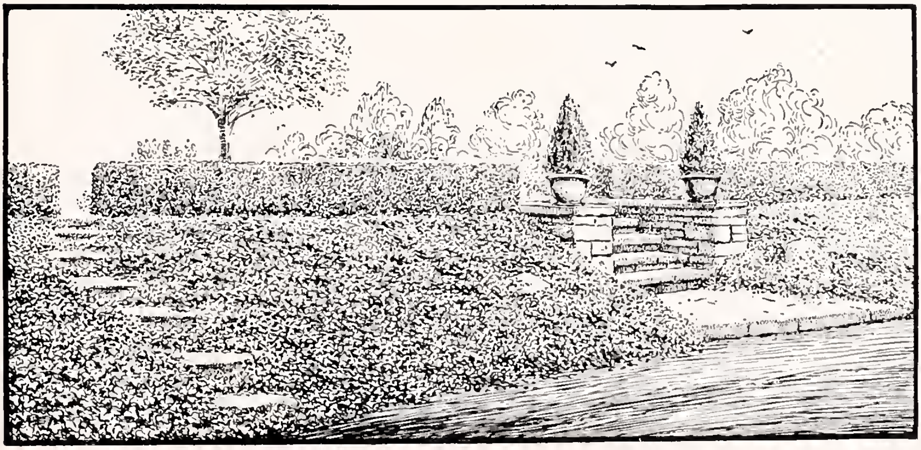
R. hispida, Rose Acacia, resembles *R. fertilis* but usually does not exceed 6 ft. in height. It grows well on dry banks and is best used in groups.

Rosa setigera, Prairie Rose. Sometimes called the "bramble-leaved" rose from the resemblance of its leaves to those of blackberry or dewberry, it is a handsome and distinct species forming a large bush with arching or climbing branches to 10 ft. or more. It bears large clusters of single pink flowers in July and is suitable for informal and naturalistic plantings.

Sophora viciifolia. An attractive bushy shrub to 6 ft. whose spiny branches are clothed with almost fern-like foliage. In June the plants are covered with fluffy clusters of blue-white flowers.

Other plants recommended are: *Acanthopanax Sieboldianus, Ligustrum ovalifolium,* see "Hedge Plants"; *Caragana arborescens, Cornus racemosa,* see "For Shade"; *Myrica pensylvanica, Rosa rugosa, Symphoricarpos orbiculatus, Tamarix odessana, Vaccinium corymbosum,* see "For Seashore"; and *Rhodotypos scandens,* see "City Conditions."

GROUND COVERS



From time to time there are situations where because of shade or steep slope it is difficult or not desirable to establish grass. The following plants can be depended upon to grow on slopes and banks and under trees, unless the soil be too full of tree roots.

Euonymus Fortunei (radicans) var. *colorata.* A variety of the popular evergreen wintercreeper, with larger and thinner leaves than the type, which turn warm purple-red in the winter. It takes root as it spreads over the ground and forms a low, dense cover of good appearance. Though hardy and easily grown it is subject to scale insects.

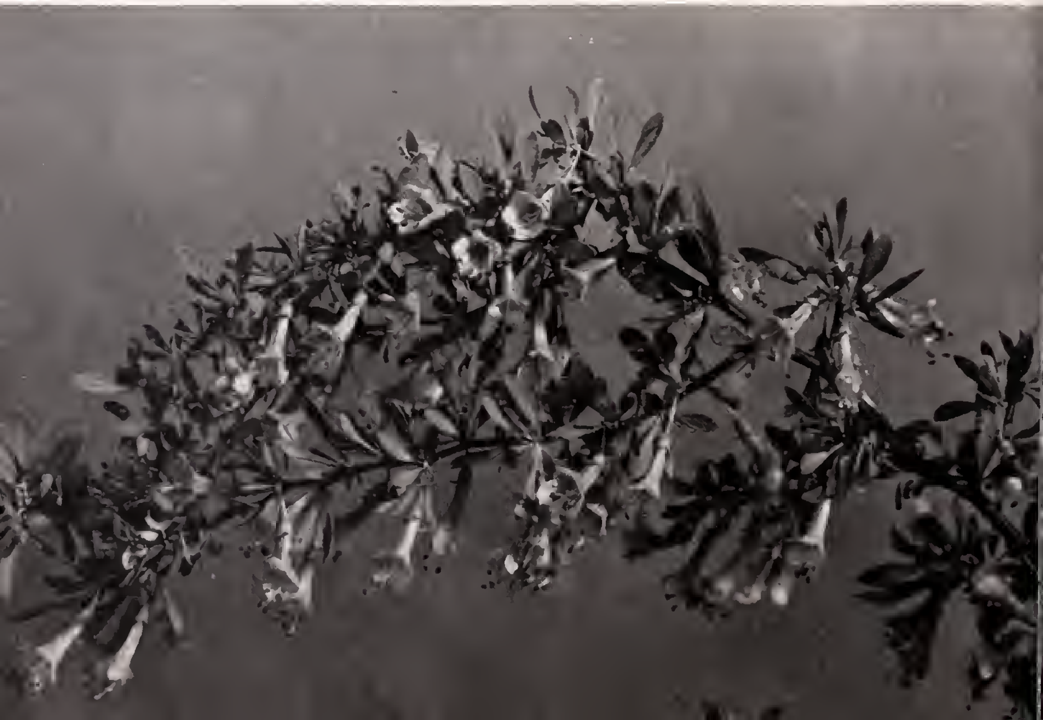
Hedera Helix, English Ivy. A popular and useful evergreen vine that grows and roots along the ground or climbs on wood or stone. It is easily cultivated and makes a good ground cover in sun or partial shade, but is liable to winter injury when climbing unless on a north or west wall. When it has climbed to the limit of its support the growth becomes bushy, the leaves thicker, glossy and unlobed and the branches bear flowers and fruit. Plants propagated from the bushy or arborescent form usually retain that habit. There is a bewildering array of varieties which may change in appearance according to period of growth or environmental factors. Among the more stable varieties are:

var. *baltica,* Baltic Ivy. This is hardier than the type, slower growing and with smaller leaves.

var. *hibernica,* Irish Ivy. This form is commonly cultivated as English ivy. The true English ivy is less vigorous and has smaller leaves whose veins turn gray-white as they mature.

Lonicera Henryi. While similar to the common Hall's honeysuckle in its vigorous spreading habit and dark green, persistent foliage, it differs in the flowers which are red or red-purple. It is perhaps a better ground cover than Hall's honeysuckle for it seems less inclined to climb.

Lycium halimifolium, Matrimony Vine. A vigorous grower with upright and arching or trailing branches that are partly spiny and form a tangled mass, or will climb if given support. During the whole summer small purple flowers are produced and these are followed by small, egg-shaped scarlet fruits. Though very effective when the long branches are laden with bright fruit, the shrub is coarse and rank and best suited for planting in difficult places such as steep slopes, or for rambling over rocks and walls. It grows well at the seashore.



Lycium pallidum. A western species with pale foliage and yellow-green funnel-shaped flowers. Rare in cultivation, but excellent for dry soil.

Pachysandra terminalis is well known as a low matting plant which grows to about 10 in. in height with dark, evergreen leaves. Since it thrives in shade and forms dense flat masses it is widely used as a ground cover, especially in locations where grass is difficult to grow, as under maple trees.

Rosa "Max Graf." A hybrid of *Rosa rugosa* that is trailing and creeping in habit. It has the thick, wrinkled leaves of *R. rugosa* and large, single flowers of bright pink, which are effectively displayed when growing on a terrace bank or similar situation.

Rosa Wichuraiana, the Memorial Rose, has long, trailing or prostrate branches with persistent glossy foliage and small white flowers. It makes a dense, spiny cover and grows well in the city. Its frequent use in cemeteries is said to have inspired its common name.

Vinca minor, Periwinkle, is a trailing evergreen subshrub that grows only a few inches high. It has lustrous, dark green leaves which make a good background for the violet flowers in spring. It will grow in sun or shade and under some conditions is capable of surviving in competition with grass.

Xanthorhiza simplicissima (**apiifolia**), Yellow Root, is native to shady banks of streams in the eastern states. Spreading by underground stems it soon forms a large clump which may vary from 1 to 4 ft. in height depending on conditions. It has leaves that are decorative and deeply cut and clusters of small, inconspicuous purplish flowers in early spring. It can be used advantageously to cover the ground beneath tall, old trees in open woods.

Other ground covers well adapted for banks and slopes are: *Akebia quinata, Lonicera japonica* var. *Halliana,* described under "Vines"; *Rhus aromatica, Rosa setigera,* see "For Light Sandy Soil"; *Symphoricarpos albus* var. *laevigatus,* see "With Showy Berries"; and *Symphoricarpos orbiculatus,* see "For Seashore."

FOR DRY SOIL

Most shrubs are tolerant of variable soil moisture conditions so long as they do not approach extremes over too long a period. A few, however, are perfectly at home in degrees of wetness or dryness that would inhibit the growth of many others; and these, at times, play an important part in garden planting. The shrubs in the following list may vary in their endurance of dry conditions; certainly none would grow in the desert, but most of them will make satisfactory growth in fairly dry soil.

Rosa spinosissima, Burnet Rose. Scotch Rose. There are a great many varieties of this Old World rose which typically is a spreading, spiny shrub of about 3 ft. with single white, yellow or pink flowers and black fruit. It is hardy and grows well under adverse conditions. A hundred years ago Scotch roses were very popular in England and William Paul in his "The Rose Garden" (1848) lists no less than 76 varieties.

var. *altaica,* Altai Rose, is of more vigorous growth than the species, reaching up to about 5 ft., and has larger white flowers.

Viburnum acerifolium, Maple-leaf Viburnum. A native species of irregular habit with upright branches to 5 or 6 ft., clothed with leaves which are lobed and roughly resemble those of some maples. The small white flowers are borne in flat clusters, and the berries which follow are black. It is cultivated mainly for the striking crimson to purple-pink color of its leaves in the fall and its ability to grow under trees in dry shaded places.

V. Lantana, Wayfaring Tree, is rounded in habit with wrinkled and rough dark green leaves. The clusters of white flowers are typical of the group and they are followed by berries that are pink and red for a while but are eventually black. Its dense growth, large size (10 ft. or more), and ability to grow in dry shaded places make it valuable for screen or boundary plantings.

V. prunifolium, BLACKHAW. A spreading shrub or small tree of 10 or 15 ft. with white flowers and blue-black fruits typical of the American species. Coloring brightly in the fall, the leaves are glossy, dark green during the summer. It differs from the other American viburnums in its stiff, horizontal branching habit.

Others recommended for dry soil are: *Acanthopanax Sieboldianus,* see "For Hedges"; *Caragana arborescens, Cornus racemosa,* see "For Shade"; *Cytisus scoparius, Lespedeza Thunbergii, Rhus aromatica, Robinia hispida, Rosa setigera, Sophora viciifolia,* see "For Light, Sandy Soil"; *Lycium pallidum,* see picture on p. 28; *Myrica pennsylvanica, Prunus maritima, Rosa rugosa,* and *Symphoricarpos orbiculatus,* see "For Seashore."

FOR SHADE

Often the surroundings are such that gardens have to be made in varying degrees of shade. Many shrubs will not thrive under such conditions; but some, even though normally found growing wild in full sun, can get along with reduced light provided the soil is enriched and plentifully supplied with moisture, which seems partially to make up for lack of sunshine. Those which are found in nature in woodlands are the first choice for a shady garden. A selection of these and others which will endure partial shade is noted below.

Caragana arborescens, SIBERIAN PEA-TREE. A tall shrub, 8 to 12 ft. or more, of upright, often narrow growth. In the spring its bright green foliage and yellow pea-like flowers are very attractive. It stands cold, dry situations and poor soil and makes a good screen planting.

var. *Lorbergii.* An odd variety with pendulous branches and almost thread-like leaflets.

Cornus racemosa (paniculata), GRAY DOGWOOD. An attractive species with slender upright stems that form a round-topped, compact mass. The height depends on growing conditions, varying from a few feet to 10 ft. or more. In early June the white flowers are attractive and so are the red-stemmed white fruits that follow. Though more refined in appearance than most of the shrubby dogwoods it spreads by suckers and forms large clumps. It is generally useful but most suitable to wild plantings.

Hamamelis virginiana, WITCH-HAZEL. A common woodland plant that may be a bushy small tree to 15 or 20 ft. or a straggling shrub. It does not attract attention until fall, when the flowers unroll their narrow yellow petals in a kind of farewell gesture. It grows naturally in moist, shady locations but thrives in full sun too. It is useful in naturalistic plantings along streams and in shady places.

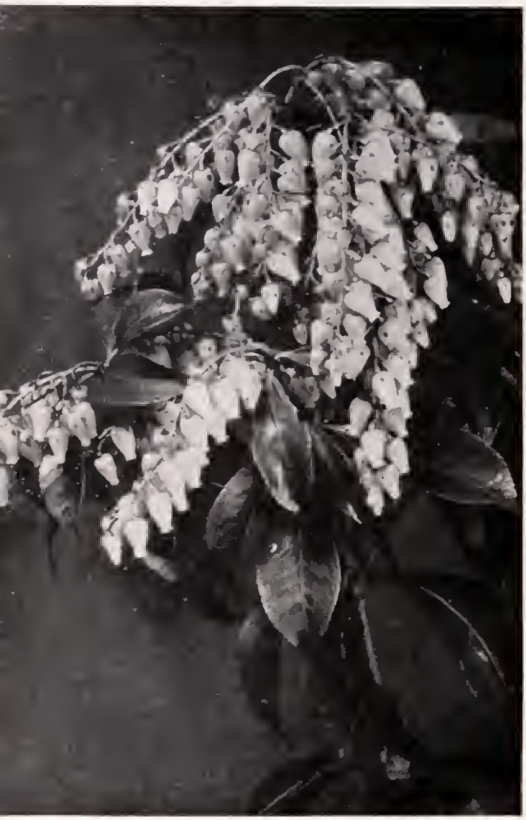
Hydrangea arborescens var. *grandiflora,* SNOWHILL HYDRANGEA. A coarse but useful and adaptable hydrangea—with upright branches that average 4 or 5 ft. in height. In June the new branches are terminated with broad flat clusters of white flowers. Severe pruning in early spring encourages more vigorous growth and larger flowers.

Kalmia latifolia, MOUNTAIN LAUREL. One of the most beautiful American plants and ranked by some as second only to rhododendron. Mountain laurel charms us with handsome evergreen foliage and large clusters of pink flowers in late May or early June. Usually it is a shrub of 6 to 8 ft., but it sometimes becomes tree-like under ideal conditions. Though an acid soil plant, it is more tolerant in this respect than rhododendrons.

Lindera Benzoin (Benzoin aestivale), SPICEBUSH. A native, growing to 10 or 15 ft. with small, clustered yellow flowers in early spring on the bare branches. The light green foliage is of good texture and turns yellow in the fall, making an attractive combination with the bright red berries. It is seen to best advantage in naturalistic plantings, particularly in moist, shady situations. It does not transplant easily and is slow to establish itself.

Pieris floribunda, MOUNTAIN ANDROMEDA. A hardy and useful slow-

Pieris floribunda. A handsome and hardy member of the Heath Family from the mountains of the south-eastern states.



Pieris japonica. An Asiatic species, handsomer than its American cousin, but not so hardy.

growing evergreen with dull, oval leaves. It is low, compact, and spreading, 3 to 6 ft. in height, and in late April bears upright clusters of small white flowers. The flower buds are developed in the fall and are an interesting feature during the winter. It prefers an acid, loamy soil.

P. japonica, JAPANESE ANDROMEDA, is taller than the mountain andromeda, reaching 6 to 9 ft., and is upright in habit. The evergreen leaves are glossy and the larger, fragrant white flowers are in pendulous clusters. It blooms about 2 weeks earlier than mountain andromeda and is handsome and rich appearing. Unfortunately it is not completely hardy and should be protected from winter wind and sun if in an exposed place.

Other shrubs recommended are: *Acanthopanax Sieboldianus, Euonymus alata* var. *compacta, Forsythia intermedia, Ilex crenata* var. *microphylla, Ligustrum ovalifolium, Ribes alpinum* and *Viburnum prunifolium,* see "Hedge Plants"; *Aronia melanocarpa, Ilex glabra, Symphoricarpos orbiculatus* and *Vaccinium corymbosum,* see "For Seashore"; *Clethra alnifolia,* see "For Wet Soil"; *Hedera Helix, Lonicera japonica* var. *Halliana,* see "Vines"; *Ilex verticillata* and *Lonicera tatarica,* see "With Showy Berries"; *Leucothoë Catesbaei, Rhododendron nudiflorum, R. Vaseyi* and others, see "For Acid Soil"; *Pachysandra terminalis, Vinca minor, Xanthorhiza simplicissima,* see "Ground Covers"; *Physocarpus monogynus* and *Rhodotypos scandens,* see "For City Conditions."

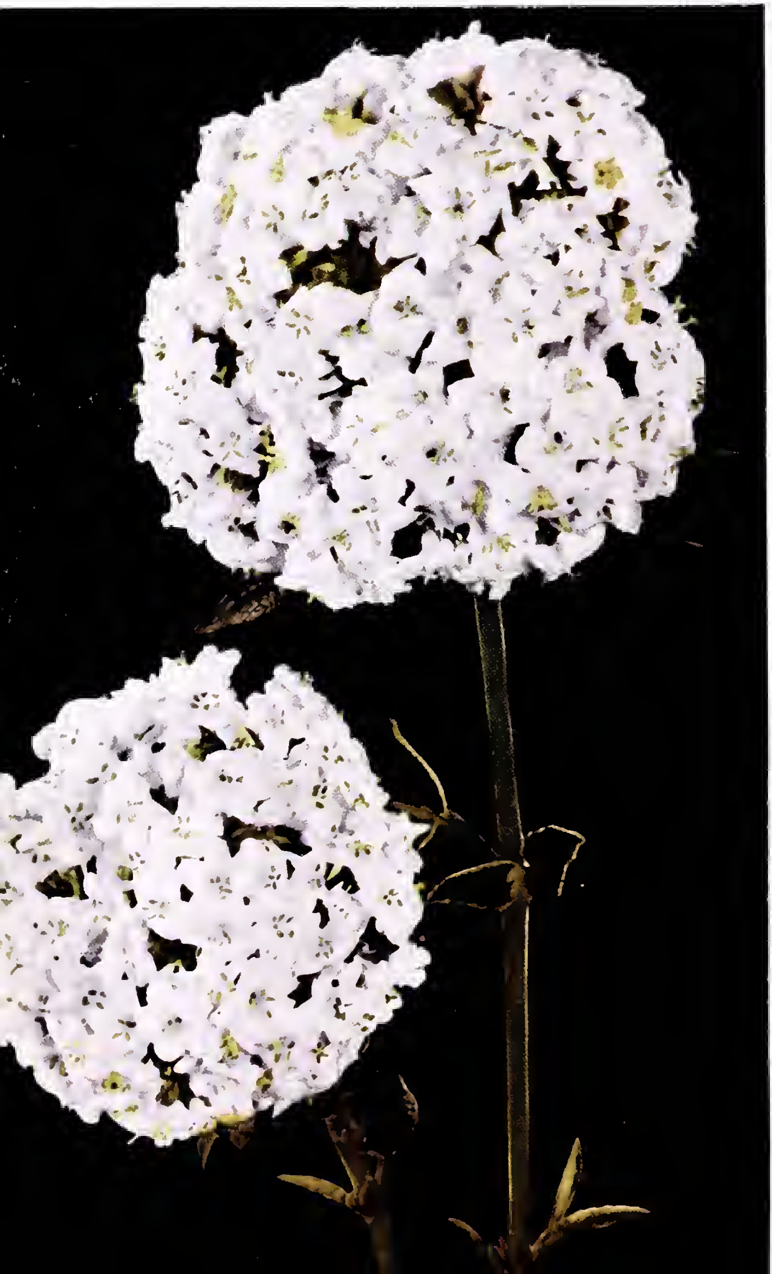
DIOECIOUS SHRUBS

When the male and female flowers are borne on different individuals the species is called dioecious. Only the female plants bear fruit and it is generally necessary to have a male plant nearby to ensure the formation of fruit when this is desired. Contrary to a popular notion it is *not* necessary to have both sexes represented to ensure the production of *flowers.* Here are some of the better-known dioecious shrubs: *Actinidia, Baccharis, Celastrus, Chionanthus, Hippophae, Ilex, Lindera, Myrica, Rhamnus, Rhus* (partly), *Salix* and *Schisandra.*

Torch Azalea, *Rhododendron obtusum* var. *Kaempferi* →

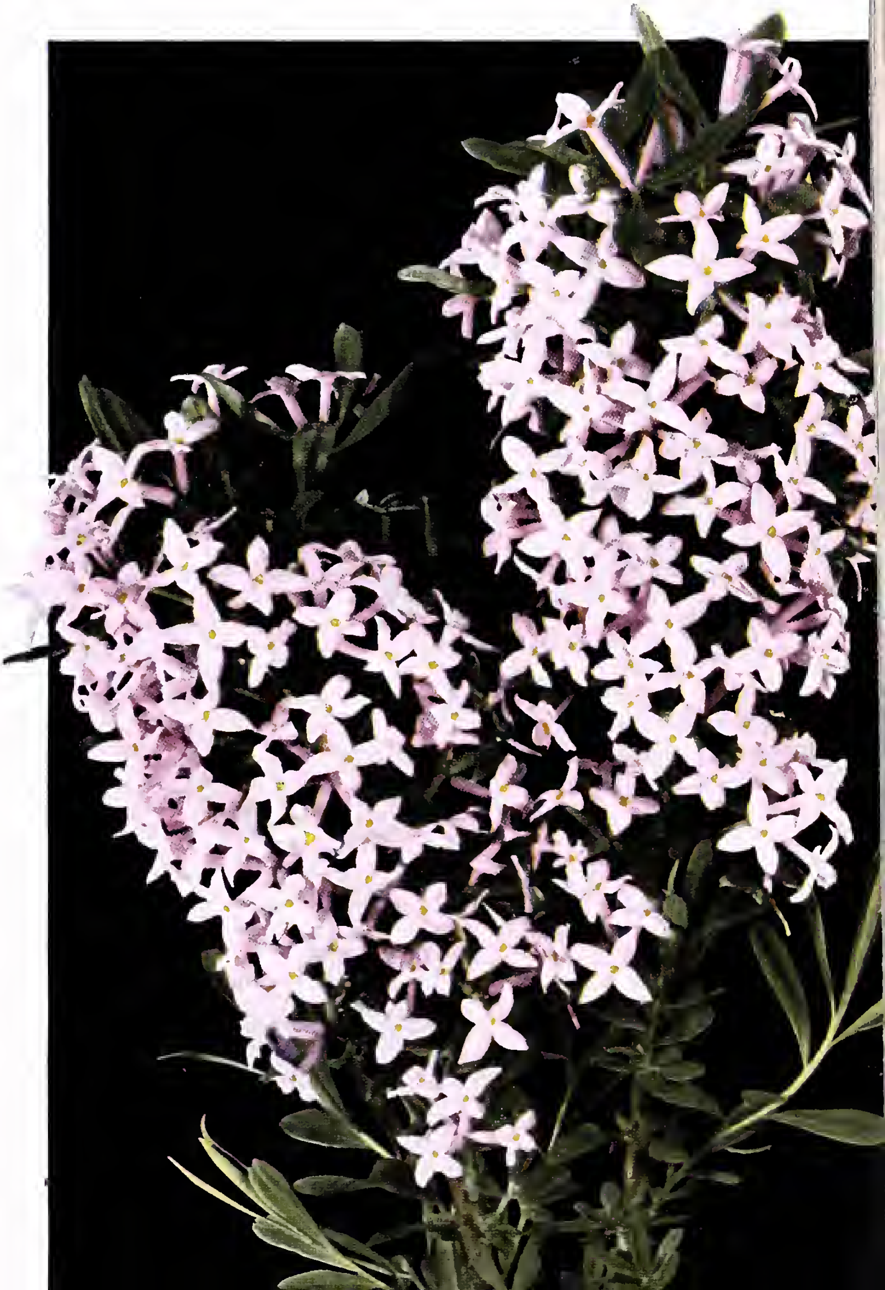
Viburnum Burkwoodii

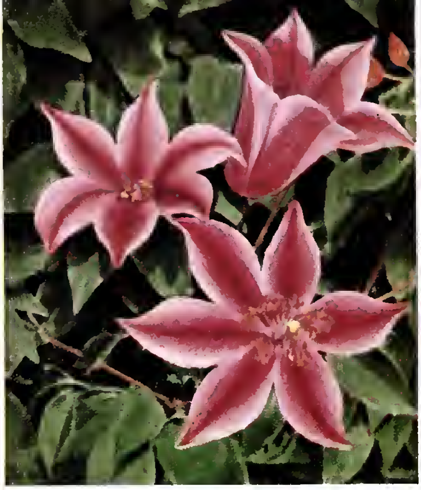
A hybrid that resembles *V. Carlesii,* one of its parents. It has large clusters of fragrant, pale pink to white flowers in early spring.



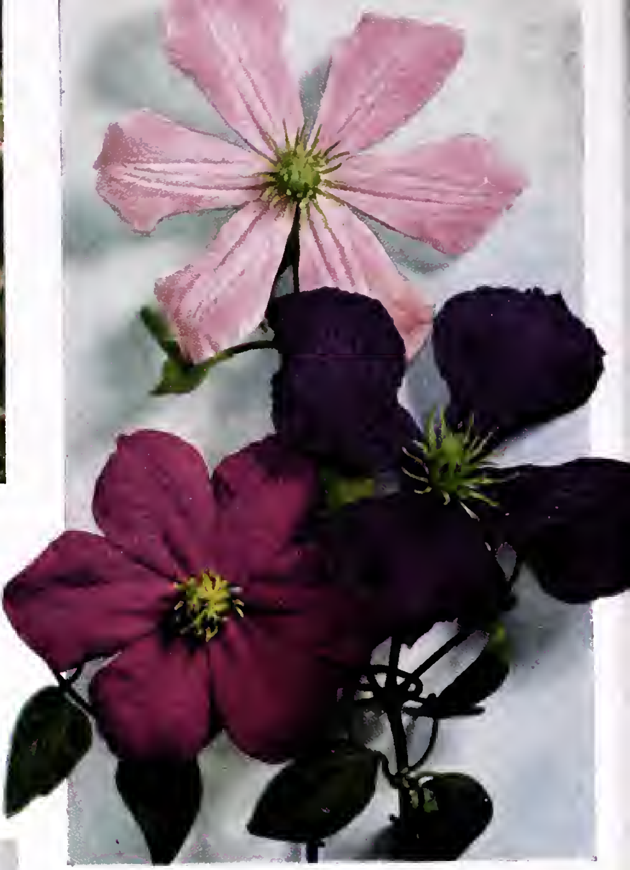
Daphne Burkwoodii var. "Somerset"

A newly introduced hybrid. It has persistent gray-green leaves and fragrant pink flowers.



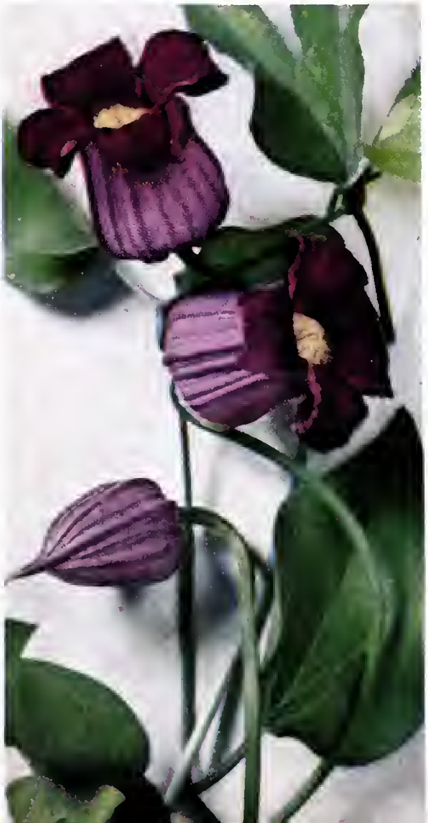


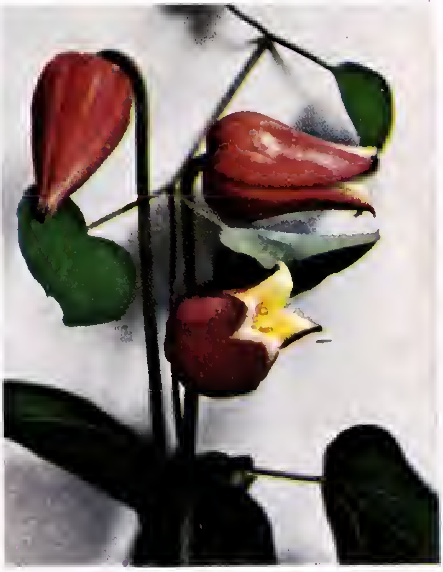
Clematis "Duchess of Albany"



Clematis Jackmanii and varieties

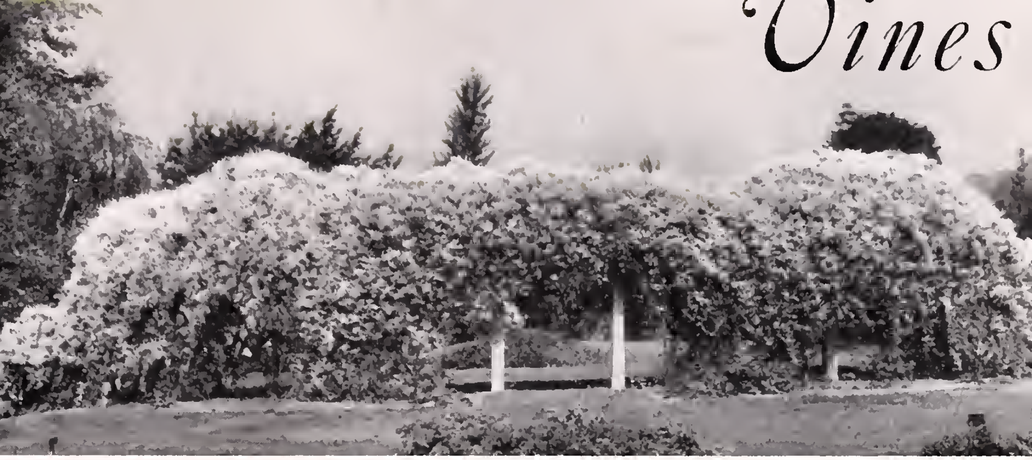
Clematis crispa





Clematis texensis

Vines



Polygonum Auberti

Vines play an important part in landscape design and serve many garden purposes. They can be grown over pergolas for shade and beauty, on fences and lattice work; they may serve as a screen to give privacy. They will provide flowers, fruit and foliage where there is not sufficient room for a shrub, thus making what might be called a vertical garden. They can be used as ground cover; or on walls to break the monotony of flat expanses of masonry.

Most of the vines in the following list are twiners, or climb by tendrils, and cannot attach themselves to flat surfaces. The names of those which cling to their support by adhesive discs or aerial rootlets are indicated by a star. They are the ones preferred for use on brick or stone.

Actinidia arguta. The TARA VINE is a climber of vigorous heavy growth and coarse foliage that is valuable in covering large pergolas, fences and slopes. The white flowers are of little ornamental

---

Descriptions of Clematis on Colored Plate Opposite

Clematis crispa. Of the many species of *Clematis* with tubular or urn-shaped flowers *C. texensis* and the marsh clematis, *C. crispa,* are the two best known in gardens. The latter is a graceful climber from the South where it grows naturally in swamps and moist woods from Virginia to Texas. It is hardy in New York City and grows to 8 or 10 ft. The flowers open during the summer and vary from lavender to purple; the thick sepals are curved and spreading at the tips and give the flowers a very pleasing bell shape. Like the Texas clematis it is attractive on pillars or trellises or in wild plantings clambering over low stone walls or shrubbery. This species has produced several interesting hybrids.

Clematis "Duchess of Albany." Although there are several hybrids of the American *C. texensis* only a few of these are now carried by nurserymen. One of the most attractive is Duchess of Albany. The petal-like sepals often have a dark band down the center and a paler tinge along the margins.

Clematis Jackmanii, see p. 34.

Clematis texensis. The scarlet or Texas clematis is a graceful, slender-stemmed species that may grow to a height of 10 ft. Its flowers vary in color from bright scarlet to pink, and though the main bloom is in late June or early July scattered flowers may be expected during the rest of the summer. First collected in Texas in 1850 and hardy as far north as Maine, it seems strange that this colorful clematis is not more widely used in gardens. It is a parent of several striking hybrids.

value but the yellow-green fruit (produced only on female plants) is pleasant tasting. This vine should be used only where its strong growth will not interfere with other plants. There are other species, but this is the most satisfactory for general use.

Akebia quinata, AKEBIA. A vigorous, high-climbing, twining vine with slender stems and attractive five-parted leaves that persist until late in the season. The reddish-brown flowers are inconspicuous and the sausage-shaped, gray-violet fruit is seldom produced. At first it is slow to establish itself but then grows freely. It thrives on fences and arbors and can be used as a ground cover.

Ampelopsis brevipedunculata (heterophylla), TURQUOISE BERRY. PORCELAIN VINE. Closely related to the grape, this vine grows rapidly and widely and may become a nuisance. During the summer the deeply lobed leaves make a dense screen and in the fall the vines are dotted with clusters of berries which change from lilac blue to china blue. Use it on trellises or over walls where it will have ample room to spread.

Aristolochia durior (Sipho), DUTCHMAN'S PIPE. A twining vine to about 30 ft. whose large overlapping leaves make a dense screen. The odd yellow flowers are concealed by the foliage and therefore of no decorative value. Though heavy and coarse in appearance it was at one time a popular porch screen, particularly when there were daughters of marriageable age in the house!

Celastrus orbiculata, ORIENTAL BITTERSWEET. A strong, vigorous climber to 30 ft. or more, with oval leaves and small clusters of persistent orange-yellow fruit along the twigs. It is valuable for covering arbors and fences though occasionally of too rampant growth. Unfortunately it is very susceptible to scale insects, though in general it is more desirable than American bittersweet.

C. scandens, AMERICAN BITTERSWEET. Vigorous twiner to around 20 ft. with pointed leaves and clusters of orange-scarlet fruits at the end of branches. It is good in naturalistic plantings but not so bushy or decorative as oriental bittersweet. Both species are subject to infestations of scale insets; and, since they are of strong growth, they should be planted only where they can spread freely and will not interfere with other plants.

Clematis Jackmani, JACKMAN'S CLEMATIS. A vine well known for its large, velvety purple flowers in late summer. It has slender branches that climb (with support) 10 to 15 ft. and makes its best growth in loamy soil with shade over its roots. There are many hybrid varieties.

C. "RAMONA" is an easily-grown hybrid of *C. lanuginosa* × *C. patens.*

C. montana, MOUNTAIN CLEMATIS, is an easily grown species that is vigorous and satisfactory and may reach 25 ft. in height. Its white flowers, an inch or two across, are usually in small clusters on wood of the previous season.

var. *rubens.* With larger, pink flowers.

C. paniculata, SWEET AUTUMN CLEMATIS. A vigorous and handsome climber whose stems may reach 30 ft. It has attractive, glossy foliage and in September is covered with lacy masses of small, fragrant, white flowers. Because of its ease of culture this is probably the most satisfactory clematis for general use.

***Hydrangea petiolaris,** CLIMBING HYDRANGEA. A handsome and desirable climber that clings firmly to wood or stone by aerial rootlets, or if support is lacking forms a broad sprawling shrub. The foliage is good and the flat clusters of white flowers in summer are decorative with an outer ring of enlarged, sterile flowers which have 4 sepals rather than 1 as in schizophragma. Hardy and vigorous, it will grow in partial shade.

Lonicera japonica var. *Halliana,* HALL'S HONEYSUCKLE, is a commonly planted trailing or twining vine with hairy, dark green leaves that are almost evergreen. Its sweetly scented, white-yellow flowers in spring, with scattered bloom in fall, have long made it a garden favorite. Able to thrive under difficult situations it is often used as ground cover for large areas or on slopes and it is fine as a screen or for covering fences. Because of its rampant growth it should be planted with caution for it sometimes escapes from cultivation and becomes a serious pest.

***Parthenocissus tricuspidata** (**Ampelopsis tricuspidata**), Boston Ivy. A deservedly popular vine whose glossy green leaves, about 6 in. across, do a great deal to relieve the monotony of city walls. Attaching itself securely by adhesive discs it forms a dense screen and may climb beyond 4 or 5 stories. The small bloomy-black fruits are of some interest and the leaves turn red and orange in the fall.

var. *Veitchii.* Leaves smaller, about 3 or 4 in. across, with less rampant growth.

var. *Lowii.* Leaves very small, about 1 in. across and deeply cut; growth slow.

Periploca sepium, Silk Vine. A twining Asiatic shrub with slender stems and narrow glossy leaves. The flowers are odd, but like the fruit, which resembles a small milkweed pod, they have little ornamental value. A hardy and handsome climber that deserves wider cultivation, for few other vines have such attractive, shiny leaves. Suckers are occasionally sent up several feet away from the parent plant and may be a drawback in some situations.

Polygonum Auberti, Fleecevine, Silver Lace-Vine. High-climbing vine of rank growth with dense light green foliage and abundant lace-like clusters of small white flowers in early fall. Widely used on the fences at the New York World's Fair, it grows rapidly even under adverse conditions.

Wisteria floribunda, Wisteria. Vigorous and high-climbing with pleasing foliage and pendulous clusters of fragrant, violet, pea-shaped flowers. Excellent for use on arbors and wire fences. It will bloom more freely if rampant new growth is cut back to 3 or 4 leaves during the summer. If plants of blooming age persistently fail to flower, root pruning is sometimes effective in making them behave. By careful and persistent pruning of the top, wisteria can be made to assume a shrubby habit.

Clematis "Ramona." Large, lavender-blue flowers with a ring of dark stamens.

var. *alba.* White flowers.

var. *macrobotrys.* Flowers in clusters sometimes 3 ft. long.

Other vines recommended are: *Hedera Helix, Lycium halimifolium,* see "For Groundcover"; *Lonicera Heckrottii,* see "For Long Blooming Period"; *Schizophragma hydrangeoides,* see "Uncommon Shrubs."

CITY CONDITIONS

Very few of the popular flowering shrubs grow well in the crowded sections of the city because of the dirt and fumes in the air and the frequently uncongenial soil. Evergreens in particular seem to dislike city life, though rhododendrons, taxus and Japanese holly grow fairly well. Yet in the downtown sections flowering plants or even mere green leaves are doubly appreciated. While many of the shrubs in the following list may not be first class ornamentals they are able to adjust themselves and get along under city conditions.

Chaenomeles japonica (Cydonia Maulei), DWARF FLOWERING QUINCE, is low and neat with slender upright and spreading branches to about 3 ft. In early May it bears showy brick-red flowers which are followed in the fall by fragrant yellow fruits.

var. *alpina*. Lower and more spreading and suckering.

C. lagenaria (Cydonia japonica), FLOWERING QUINCE, grows to 6 ft. in height, with stiff spiny branches and lustrous leaves. It has long been popular in gardens for its bright clusters of early flowers—which vary in the varieties from scarlet to white. The fruit is yellow and fragrant and can be made into jelly.

Hydrangea macrophylla. The common greenhouse or "French" hydrangea with thick leaves and broad clusters of flowers that are pink when growing in alkaline soil and blue when in acid soil. It is a popular tub plant and thrives along the seashore, and though root-hardy about New York City the flower buds are frequently winter killed. Prune only lightly in the spring, for in many varieties the flowering shoots develop from the ends of the previous year's growth.

Ligustrum ibolium. A hybrid form that closely resembles California privet (*Ligustrum ovalifolium*), one of its parents. It has the same dense habit and glossy persistent leaves but is appreciably hardier. It thrives under conditions that would discourage most plants and is particularly good as a screen or hedge.

Physocarpus monogynus, MOUNTAIN NINEBARK, is a dense shrub growing to a height of about 5 ft. with slender arching branches and clusters of small white flowers. Pleasing and compact in habit it can be used as a lawn specimen, in foundation plantings or as a low hedge.

Rhodotypos scandens (kerrioides), JETBEAD, is coarse and bushy, growing 5 to 6 ft. or more with light green pointed leaves. The attractive, single white flowers are borne in May and June and are followed by clusters of shiny, hard black fruits that persist over winter. It is tolerant of shade and adverse growing conditions though too coarse for refined plantings.

Symphoricarpos albus var. *laevigatus* **(S. racemosus)**, SNOWBERRY. A slender-stemmed and suckering plant that grows to around 4 or 5 ft. in height and has small inconspicuous pink flowers during the summer. Its chief ornamental feature is the large pure white fruit that ripens in the fall and lasts until frozen. Its compact, suckering growth, however, and ability to thrive in shady difficult places give it appreciable garden value—it makes a good filler or facer for larger plantings and grows well on slopes.

Other plants recommended for city conditions are: *Acanthopanax Sieboldianus, Berberis Thunbergii* and varieties, *Forsythia intermedia, Ilex crenata* var. *microphylla, Ligustrum ovalifolium, Ribes alpinum, Viburnum Sieboldii,* see "Hedge Plants"; *Cornus racemosa,* see "For Shade"; *Lonicera fragrantissima, Ribes odoratum, Syringa vulgaris* and varieties, see "With Fragrant Flowers"; *Lonicera japonica* var. *Halliana, Lycium halimifolium,* see "Vines"; *Rhododendron* hybrids, see "For Acid Soil"; *Salix discolor,* see "For Wet Soil"; *Symphoricarpos orbiculatus,* see "For Seashore"; *Viburnum dilatatum,* see "With Showy Berries"; *Viburnum Lantana,* see "For Dry Soil"; and *Hibiscus syriacus,* see "Long Blooming Period."

PLANTS

Ligustrum ovalifolium (tall), *Euonymus alata* var. *compacta* (low)

Some of us like privacy in our gardens and, apart from this desideratum, sometimes find it necessary to erect a defensive barrier against roving dogs, inquisitive boys (or girls), or even a neighbor's cow. There are different ways of attaining these ends, but one of the very best is by means of hedges of tall-growing plants—either spiny or innocuous, depending upon the purpose in view.

There are several characteristics that a shrub should possess to qualify as a good hedge plant: it must be hardy and disease resistant so that the planting will be permanent; it should be of naturally compact growth or else easily made so by shearing; the foliage should be of pleasing color and texture, and if there are attractive flowers or fruits so much the better. If labor is at a premium those plants which remain neat even though unsheared have special appeal.

Acanthopanax Sieboldianus, the Five-leaf Aralia, is strong and hardy, varying in height from 6 to 10 ft. with mildly prickly, upright and arching branches whose tips take root if and when they touch the ground. The glossy, bright green, 5-parted leaves are the main attraction of the plant, aside from its strong constitution, for the flowers and fruits are not outstanding. It makes a good sheared hedge or spreading, informal boundary planting and is one of the most enduring in shade and under city conditions.

Berberis amurensis var. *japonica,* Amur Barberry. Though not commonly grown, Amur barberry is a very good choice for a tall, untrimmed barrier planting. It is strong and spiny with stiff, upright branches that average between 8 and 10 ft. in height. In the spring they are gay with yellow flowers and these are followed by clusters of attractive red berries that ripen early in the fall.

B. Thunbergii, Japanese Barberry. This has all the requirements of a good hedge plant with some to spare. It is hardy and has few, if any, pests; in habit it is dense and compact with stiff, slender, spiny branches that interlace and form an impenetrable barrier. The leaves are of fine texture, a pleasing shade of green, and color brightly in the fall. In addition to all this there are bright red berries that ripen in late summer and remain effective over most of the winter, often presenting a pleasing appearance against the fresh green of the developing shoots. Japanese barberry will stand shearing but it is more handsome and effective if allowed to grow naturally.

var. *minor,* BOX BARBERRY. A dwarf form with the good qualities of the type but smaller in all respects. It does not need trimming but by shearing it can be kept down so that it is many years before it attains a height of more than a foot.

Euonymus alata var. *compacta* is a form of the winged euonymus that is lower and more compact in habit. It is of moderate growth, eventually reaching 5 ft. in height and is easily kept fairly low by one trimming a year. The foliage colors to a bright crimson in the fall.

Forsythia intermedia. Though usually grown for its early yellow flowers, this makes an excellent tall screen planting. Of vigorous growth it eventually forms a dense rounded mass of about 10 ft. with dark green foliage. It is not adapted to shearing, and because of its spreading habit it is more suitable in large plantings where it can grow without restraint.

Ilex crenata var. *microphylla.* A dense, twiggy, slow-growing variety of the Japanese holly with small, dark, evergreen leaves. Rich and dignified in appearance it is handsome either sheared or growing free. When not restrained it may, after many years, reach 10 or 12 ft. in height. It is not completely hardy here, and the branches may be killed back as a result of an unusually severe winter.

Ligustrum ovalifolium, CALIFORNIA PRIVET. The many good qualities of this privet have made it a widely popular hedge plant. It grows readily and rapidly and has handsome foliage that hangs on late in the season. At least 2 shearings a summer are necessary to keep a formal hedge in shape; left to itself it forms a dense, billowy shrub to 12 or 15 ft. and makes a good screen. Lack of hardiness is its main drawback; it grows well in the city and at the seashore. It is native to Japan and not California as the common name would imply.

Prinsepia uniflora. A picturesque shrub with arching or almost pendulous spiny branches and attractive glossy foliage. It forms an impenetrable barrier that requires no care or shearing and will grow in dry soil. A hedge in the Brooklyn Botanic Garden, over 25 years old, did not exceed 6 ft. in height. Unfortunately it is carried by only a few nurseries.

Ribes alpinum, MOUNTAIN CURRANT, is uncommon, but very good for a low, dense hedge. It is a neat, compact plant, growing to 4 or 5 ft. high, with stiff branches and small, dark green leaves. Because of its hardiness and ability to grow well under poor conditions it has many garden uses. Unfortunately it is a host of the white pine blister rust and should not be cultivated where the white pine or other 5-needled pines are growing.

Viburnum Opulus, var. *nanum,* DWARF CRANBERRY BUSH, is dwarf and of dense, billowy habit, rarely exceeding 3 or 4 ft. in height, and seldom flowering. It grows slowly, requires little care and no shearing and makes an effective low hedge.

V. prunifolium, BLACKHAW. A native that is valuable in informal plantings. It grows to 10 ft. or more in height with stiff, horizontal branches and glossy green leaves that color brightly in the fall. The attractive flat clusters of white flowers and blue-black fruit are freely borne if the branches are not sheared.

V. Sieboldii, SIEBOLD VIBURNUM, is a vigorous, coarse, Asiatic shrub or small tree, eventually growing to 20 ft. or more. It has handsome, lustrous foliage and large clusters of white flowers. It can be sheared but is best used as a tall informal screen plant. Squeamish people may object to the penetrating odor of the fallen leaves.

Other plants recommended for hedges are: *Cornus racemosa,* see "For Shade"; *Hibiscus syriacus, Ligustrum ibolium, Physocarpus monogynus, Rhodotypos scandens,* see "City Conditions"; *Lonicera tatarica,* see "With Showy Berries"; *Rosa rugosa,* see "For Seashore"; and *Viburnum Lantana,* see "For Dry Soil."

Philadelphus virginalis var. *Virginal* has delightfully fragrant flowers but poor growth habit.

WITH FRAGRANT FLOWERS

Fragrance adds immeasurably to the charm and attractiveness of a garden, giving it life and personality. At one time, when not so many desirable shrubs were available for garden use, appreciably more value was attached to plants with fragrant flowers or foliage. Several shrubs, not particularly ornamental, owe their continued cultivation to the sentimental associations of their fragrance.

Calycanthus floridus, SWEET-SHRUB. This is an aromatic, coarse-leaved, American shrub with inconspicuous, dull red flowers, long popular in gardens for its fragrance alone. Unfortunately much of the material sold by nurserymen apparently has little if any scent so intending purchasers should be careful to insist on a fragrant specimen or none at all, for it is hardly worth growing for any other purpose. It prefers moist soil, will stand shade, and grows well in the city.

Daphne Burkwoodii var. *Somerset.* A newly introduced hybrid which grows to a height of 2 or 3 ft. In May the upright branches are crowded with clusters of fragrant pink flowers; the gray-green leaves are said to be evergreen in the southern states but here they drop in the fall. It is evidently hardy and easily grown, and should be valuable in foundation plantings or any place moderately supplied with sunshine where a low-growing shrub is required.

Daphne Cneorum, ROSE DAPHNE. This differs in habit from that of the preceding and forms a low, usually evergreen mass to 1 ft., with spreading or prostrate branches clothed with narrow, light green leaves. In May, and occasionally during the summer, the branches are tipped with rounded clusters of sweet-scented, rose-pink flowers. It is splendid in rock gardens or low evergreen plantings. While hardy, it is often difficult to establish and sometimes dies from no apparent cause. It prefers moist but well drained soil and will not thrive in hot, dry situations. It should be shielded from winter sun to prevent browning of the foliage.

Lonicera fragrantissima, WINTER HONEYSUCKLE. Outstanding for its good habit and foliage, this shrub is compact and rounded in outline, with smooth thick leaves which do not fall until early winter. Beginning in late March the waxy white flowers open over several weeks, and though not showy they are delightfully fragrant. It needs ample space in which to develop for it may reach 12 ft. in height with a spread of over 20 ft. Obviously it is not adapted to small plantings but is good as a lawn specimen or in large shrub borders.

Magnolia stellata. This is commonly called STAR MAGNOLIA because of the many long, narrow white petals. It is the first magnolia to bloom, with the fragrant flowers freely borne and opening about mid-April. Unless planted in a protected place the flowers are apt to be injured by wind and frost. It is compact with attractive foliage which is colored yellow and tan in the fall. Although slow-growing, it eventually attains a height and spread of 12 or 15 ft. A splendid species which looks well growing by itself or in groups.

var. *rosea.* Flowers are pale pink.

Philadelphus coronarius, MOCK-ORANGE. A large, rounded, spreading shrub 8 to 12 ft. in height, which has long been a garden favorite because of its abundant, handsome, sweetly scented white flowers. While useful in large borders it cannot be considered distinguished except when in bloom. It should be pruned by cutting out old flowering branches as soon as blooms fall.

var. *pumilus.* A dwarf compact form usually about 3 or 4 ft. high, which seldom blooms.

Ribes aureum, GOLDEN CURRANT. This and the buffalo currant (*R. odoratum*) are much alike and are both old garden favorites prized for their early spice-scented yellow flowers. They average about 6 ft. in height and have arching branches and gray-green leaves. Valued chiefly for their early flowers and ability to grow under adverse conditions.

Rosa centifolia, CABBAGE ROSE. An upright shrub, with thick dull leaves, which grows to about 6 ft. The deep pink flowers are very fragrant and very double, with overlapping petals somewhat in the manner of cabbage leaves, hence the common name. This rose is mentioned in the writings of Roman historians and has been cherished for centuries for its sweet fragrance.

R. damascena, DAMASK ROSE. A vigorous, spiny rose that may attain 6 or 8 ft. in height. The very fragrant, double flowers are borne in clusters and range in color from white to red. Cultivated since ancient times, this species is the source of most of the genuine attar of roses and is of interest because it is one of the parents of the hybrid perpetual roses.

R. Eglanteria, SWEET BRIER, EGLANTINE. A strong plant with arching branches that may reach 8 ft. in height. While the single pink flowers are attractive, in this case it is the foliage that is fragrant, particularly on calm, moist, warm days when the scent may be noticed several feet away. Sweet brier, along with dog rose (*R. canina*), is common in the hedgerows of England, and since the war started their hips are collected and widely appreciated as an additional source of vitamin C.

Syringa vulgaris, COMMON LILAC. The familiar and popular lilac of our gardens. Usually a shrub with upright branches it is occasionally tree-like to 20 ft. Hardy and persistent, it has been cultivated for generations for its fragrant lilac flowers. There are many varieties and "hybrids." For an account of these and their cultivation see Brooklyn Botanic Garden Guide No. 12, July 1941, "Lilacs in the Brooklyn Botanic Garden."

Viburnum Carlesii. Of all the viburnums this one has the most attractive flowers. Hailing from Korea it is usually a low, loosely rounded shrub of 4 to 6 ft. with gray-green leaves. The sweetly scented May-borne flowers are in dense clusters, orange-pink on the outside but white within. All the flowers do not open at the same time and the clusters are particularly charming when the white flowers are mixed with the colored buds. Quite hardy, it prefers well drained soil, and can be used either as a specimen or in groups.

Other shrubs noteworthy for their fragrance include: *Clematis paniculata,* described under "Vines"; *Clethra alnifolia,* see "For Wet Soil"; and *Rosa rugosa,* see "For Seashore."

Symplocos paniculata. No other shrub hardy in Brooklyn has fruit of such bright sapphire-blue.

WITH SHOWY BERRIES

The majority of shrubs bloom in the spring, and during the remainder of the season their only contribution to the landscape effect is a mass of restful but sometimes monotonous foliage. Everyone appreciates color in the garden, particularly in the fall, and, since there are few shrubs in bloom then, a simple and effective way to get color is from the fruits of shrubs and vines. By careful selection we can have bright berries on the home grounds from midsummer, when the honeysuckles ripen their jewel-like fruits, until midwinter. Obviously, shrubs like the honeysuckles and viburnums that bloom freely in the spring and are heavy with fruit in the fall, are particularly desirable. An autumn garden of white, orange, red and blue berries can be just as gay and bright as any spring flowering planting.

Callicarpa japonica, Japanese Beautyberry. This is a bushy shrub with upright branches reaching 6 to 10 ft. Like the Chinese species it bears clusters of pink flowers in June that are of only passing interest. In late September the abundant lilac-violet fruits of peppercorn size begin to ripen and then the shrub attracts considerable attention. With us this species has proved more satisfactory than the Chinese form; it is not completely hardy and is better planted in a sheltered place. The American species, *C. americana,* found from Virginia to Texas, is not hardy here.

Cotoneaster apiculata. A particularly good low-growing plant, compact in habit with somewhat horizontal branches and abundant large, bright red fruits. It can be used to advantage in foundation plantings and rock gardens.

C. divaricata grows to 6 ft. It has slender, spreading and arching branches with bright red berries and small dark green leaves which turn red in autumn. This species is attractive in mass or boundary plantings.

C. racemiflora var. *soongorica.* In the fall the gracefully arching branches of this vigorous shrub are laden with large, coral-red fruits. It grows to about 6 ft. in height, has pale green foliage and altogether is a very attractive species.

Ilex verticillata, WINTERBERRY. A common inhabitant of swamps in this area is this tall, somewhat upright shrub of 6 to 9 ft. It is cultivated mainly for its persistent bright red berries; both male and female plants must be present to insure fruiting. It will thrive in ordinary garden soil and is useful in informal plantings, or for naturalizing. It is frequently used to embellish Christmas wreaths made up of fruitless sprays of the evergreen holly.

Lonicera Maackii, LATE HONEYSUCKLE, is vigorous, and wide-spreading to 15 ft. or more in height and width. It has dark green leaves which in the variety *podocarpa* last into November. The large white-yellow flowers are attractive in May and give rise to abundant berries that ripen to a bright red in October and are conspicuous until eaten by birds or frozen. This is the largest of the bush honeysuckles and one of the last to ripen its fruit. It demands ample space in which to develop.

L. tatarica, TATARIAN HONEYSUCKLE. The most popular, though not necessarily the best, of the bush honeysuckles. Generally it is vigorous and bushy to about 10 ft. in height with abundant flowers that open in May and vary from white to pink. The flowers are followed in a short time, usually in July, by bright red or orange berries. It has long been a favorite because of its hardiness, rapid growth and attractive flowers and fruit.

Photinia villosa. A large, spreading shrub or small tree which grows to 15 ft. or more. It has thick, dark green leaves that color brightly in the fall, compact clusters of white flowers in the spring, and persistent oval red berries in the fall. It is handsome, hardy and easily grown, and good when used as a lawn specimen or in shrub borders.

Pyracantha coccinea var. *Lalandii,* FIRETHORN. A dense shrub with slender spreading branches of 6 to 8 ft. or much more if trained against a wall, a purpose for which it is well adapted. The clusters of white flowers are followed by bright orange-red fruits in the fall and are well set off by the small, semi-evergreen leaves. It is very decorative though slightly tender and best grown where sheltered from winter wind and sun.

Rosa multiflora, MULTIFLORA ROSE. A vigorous, bush-like species that may have a height and spread of 6 ft. or more, with branches that are sometimes climbing. It is handsome when in bloom with its many large clusters of single white flowers and again in the fall when the small, persistent red fruits are ripe. It is commonly used as an understock on which hybrid tea roses are budded and is one of the parents of the popular polyantha roses. Informal and naturalistic plantings suit it best.

var. *cathayensis,* CATHAY ROSE. Bright pink flowers and slender, often climbing branches.

Symplocos paniculata, SAPPHIREBERRY. The many good features of the sapphireberry place it among our leading ornamental shrubs. A spreading or bushy shrub, or at times a small tree of 8 to 15 ft., it has clusters of attractive white flowers in May. The berries ripen in September and are unique in their bright blue color. Unfortunately, or fortunately in the opinion of bird-lovers, the birds consider the fruits a delicacy and may completely strip the bushes as soon as the fruit is ripe.

Viburnum dilatatum. For general landscape work this is probably the most satisfactory of all the viburnums. Compact and oval in outline, it varies in height from 6 to 10 ft. Abundant clusters of small, white flowers are conspicuous against the dark green leaves in June. The fruits begin to color in early September and when ripe are bright scarlet, making a brilliant display for a month or more until they are frozen.

var. *xanthocarpum.* Fruit yellow.

Other shrubs recommended for showy berries are: *Aronia arbutifolia, Rosa rugosa* and *Symphoricarpos orbiculatus*, see "For Seashore"; *Berberis Thunbergii*, see "Hedge Plants"; *Lindera Benzoin*, see "For Shade"; *Lonicera iberica*, see "Uncommon Shrubs"; and *Lycium halimifolium*, see "Ground Covers."

Viburnum dilatatum. The best of the red-fruited viburnums.

Actinidia arguta. A strong vine with inconspicuous flowers but sweet, palatable fruits. See "Vines," p. 33.

Clerodendron trichotomum produces fragrant white flowers over several weeks and has attractive fruits.

LONG BLOOMING PERIOD

One of the most important reasons for planting shrubs is for the decorative effect of their flowers. A great many of them bloom for only a few days in the spring and during the rest of the season are merely masses of green foliage. A few, however, bloom over several weeks and these are of particular value. In small gardens where space is limited it is especially important to choose those that will be effective over the longest period. The following list is short but the shrubs named bloom for many weeks.

Abelia grandiflora. In Glossy Abelia we have a handsome shrub that varies in height between 4 and 6 ft. Tinged with red, the slender branchlets bear small, glossy, dark green leaves, and from late June through October clusters of attractive, small pink-white flowers; after the flowers have fallen the persistent calyxes turn red. It is not thoroughly hardy here but if protected from the wind it will come through most winters without injury. Having an air of refinement it is useful in foundation plantings and situations where it might receive close scrutiny.

Buddleia Davidi, Butterfly Bush. A vigorous grower to 10 ft. or more with upright and arching branches and large, opposite leaves. Long, pointed spikes of lilac flowers terminate the growths of the current season from July until frost. The top growth is not entirely hardy in this area, but this is no disadvantage, for severe pruning in the spring necessitated by winter killing encourages better growth and flowering.

var. *Charming.* Flowers pink.

var. *Ile de France.* Flowers purple.

Clerodendron trichotomum, Harlequin Bush, Glory-bower. Valued for its showy late-summer flowers and attractive fruits. Generally it suckers freely and grows to around 10 ft. in height, though occasionally it develops as a small tree. The foliage is dense and coarse, and rank smelling when bruised. Beginning to open in July, the fragrant white flowers are produced over many weeks and are followed by attractive blue fruits. It is not completely hardy and should be planted where it will have some protection from the winter wind and where it can spread at will.

Cytisus nigricans, SPIKE BROOM. A pleasing little shrub, growing to 3 or 4 ft., whose slender upright branches end in long, narrow racemes of yellow flowers that begin to open in June and continue over several weeks.

Hibiscus syriacus. The familiar ROSE OF SHARON, OR SHRUB ALTHAEA, is valued in our gardens for its upright growth and long season of bloom. It is usually a narrow upright shrub to about 10 ft. or occasionally a small spreading tree. The flowers are single or double, vary from white to red with a few poor magenta shades and bloom from late July through September. It stands city conditions well and makes a tall, narrow hedge. The specific name *syriacus* is misleading for the plant is found wild in India and China but not in Syria. Prune in spring. There are many varieties.

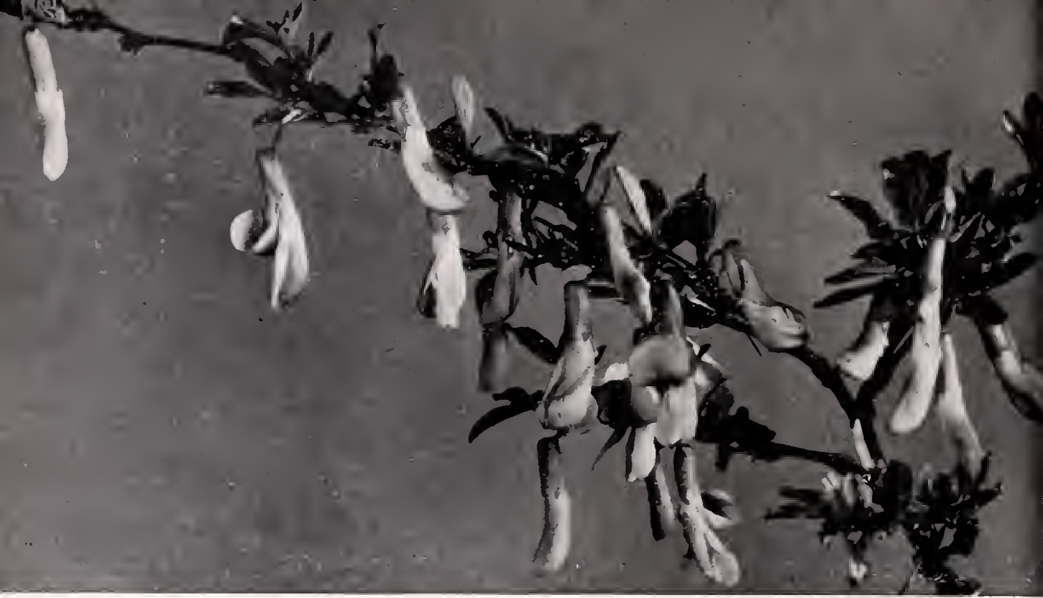
var. *Totus albus.* Single white.
var. *Jeanne d'Arc.* Double white.
var. *Rubis.* Single red.
var. *grandiflorus superbus.* Single pink.

Lonicera Heckrottii is a spreading or somewhat twining shrub with gray-green leaves. The trumpet-shaped flowers are lilac-rose outside and gold within, and bloom from June until frost. It is a handsome honeysuckle which, like many of its kind, needs regular spraying against aphids.

Rubus odoratus, FLOWERING RASPBERRY, is a native shrub with upright branches of 4 to 6 ft. and more. It has large, coarse leaves and clusters of single, rosy-purple flowers an inch or more across, that open over several weeks. The fruit is red and mildly palatable. This plant spreads by suckers and while too coarse for refined plantings it is useful on banks and in shaded woodsy places.

Other shrubs recommended are: *Aesculus parviflora* (below); *Caryopteris incana, Leptodermis oblonga,* see "Uncommon Shrubs"; *Polygonum Auberti,* see "Vines"; and *Rosa rugosa,* see "For Seashore."

Aesculus parviflora is valued for its attractive flowers in summer



Caragana Chamlagu. Uncommon but worth while.

UNCOMMON SHRUBS

The shrubs in this list are classed as uncommon, for while they are not necessarily new to cultivation they are seldom seen in ordinary plantings. They all are of definite garden value. They are mentioned here to bring them to the attention of those who are interested in growing unusual plants, or are so weary of seeing the same shrubs used over and over again that they wish to add variety and new interest to their gardens. Many of them are not readily available from nurserymen but they are worth shopping around for and trying out when they are encountered. If you are really anxious to obtain any of these shrubs and are unable to locate a source of supply drop us a line—we may be able to tell you where to get it.

Abelia chinensis, Chinese Abelia. One of the parents of the popular glossy abelia. With us it has proved more hardy than that hybrid but it is not so attractive. It is a low grower of about 4 ft. with arching branches. During the summer and fall it has small white flowers in compact clusters. The calyxes remain after the flowers have dropped and turn dull pink. While not in the same class as glossy abelia it is useful for its long-flowering character.

Aesculus discolor. A handsome and hardy large shrub related to the buckeyes with dark green leaves and, in May, erect slender panicles of bright red flowers that are effective for 2 or 3 weeks.

Buddleia alternifolia grows to 10 or 12 ft. with slender, arching branches and narrow, alternate leaves. In late May small, tight clusters of lavender flowers are produced along the growth of the previous season. It is hardier and quite different in habit from the common buddleia and should be pruned just after blooming, rather than in the spring.

Caragana Chamlagu. This is a comely species with upright, spreading branches to 4 or 5 ft. in height and more in width. Its leaves are dark green and glossy, and in May the branches are strung with yellow pea-like flowers that turn red as they age. It is hardy and can be used in general shrubbery work and as a low, informal hedge.

Caryopteris incana, BLUE BEARD. The flowers of this little shrub give a welcome touch of blue to the garden in early fall. It varies in height but is generally about 3 ft. The small, gray-green leaves are aromatic, and in August and September clusters of lavender-blue flowers are borne over several weeks. It is not entirely hardy and needs protection from winter winds; it is sometimes treated as an herbaceous plant and cut to the ground each spring.

Corylopsis pauciflora, WINTER HAZEL. Valued chiefly for its small clusters of pale yellow flowers in April before the attractive, pale green leaves develop, it is a spreading, slender stemmed shrub which may in time exceed 6 ft. in height, though usually it is lower.

C. sinensis. Of the various winter hazels this one has proved the most attractive. It grows fairly rapidly and may eventually attain 10 ft. or more. During April it bears pendulous, many-flowered clusters of pale yellow and in the summer its leaves are pleasing gray- or blue-green. It develops best in good soil and a sheltered situation.

C. spicata is hardy and distinctive, growing to 6 ft. or more with interesting, somewhat zig-zag branches, pendulous spikes of yellow flowers (larger but less numerous than those of *C. sinensis*) in April, and good foliage during the summer.

Cyrilla racemiflora is an upright shrub to 6 ft. or more with lustrous leaves that turn red in the fall, and profuse clusters of tiny, white, fragrant flowers. It is native to the southern states and seldom seen in northern gardens but is of definite value in sheltered situations.

Daphne Genkwa. More suggestive of a kind of miniature lilac than a daphne is this shrub of about 2 ft. whose upright branches bear clusters of lilac flowers in late April or early May before its leaves develop. It enjoys a light, acid soil and is a plant for protected spots in the rock garden or refined plantings.

Fothergilla Gardeni. Compact, slender-stemmed little species to about 3 ft. In early spring, just as the leaves are unfolding, the upright branches are tipped with erect clusters of white flowers. It prefers sun and a light soil that is moist but well drained.

F. major. Handsome and large, compact in habit and varying in height from 8 to 12 ft. The spike-like clusters of white flowers with long, thick stamens in early May resemble small bottle-brushes. The rounded, dense foliage colors brightly in the fall. It prefers moist, well-drained soil. It is good in the border or as a specimen and has no pests. The flowers have no petals—the white stamens are the attractive feature.

Franklinia alatamaha (Gordonia a.). A beautiful native shrub with upright branches or small tree to 15 ft. or more.

Corylopsis sinensis. Early-blooming with fragrant yellow flowers.

During the summer the oblong leaves are glossy green but in the fall they assume brilliant colors. The large flowers (white with golden stamens) begin to open in August and continue through September. A splendid plant for autumn bloom when growing in slightly moist soil in a situation sheltered from wind. Originally discovered in Georgia, it has not been found growing wild since 1799.

Hamamelis japonica, JAPANESE WITCH-HAZEL. A shrub with wide-spreading branches, generally around 10 ft. in height but may be much taller or tree-like. It is grown for its bright yellow flowers which may appear during January, February or March, depending on the weather. The flowers remain in good condition for 2 or 3 weeks, the strap-shaped petals rolling up on bad days and unrolling again when the sun comes out. It grows well in sun or partial shade, though not so tolerant of shade as *H. virginiana.*

Fothergilla major. Compact, with coarse foliage, and white flowers in early spring.

H. mollis, CHINESE WITCH-HAZEL, is similar to the preceding species but has larger and brighter flowers that open a little earlier. The leaves are gray-green and covered with soft hairs. It is generally considered the most desirable witch-hazel.

H. vernalis. An American species that resembles its Asiatic cousins in time of bloom but is quite different in habit. Compact in outline the upright branches reach to 10 ft., and the plants, which spread by suckers, may be 15 ft. or more across. The small flowers, varying from yellow to copper, are sweetly scented. It thrives in sun or shade in average soil and is useful in naturalistic plantings.

Indigofera Gerardiana. A handsome shrub to around 6 ft. with attractive, fine-textured foliage and spikes of small, purplish, pea-like flowers on new growth over several weeks. It is a good shrub but not thoroughly hardy and is best used in sheltered places.

I. incarnata (decora). Usually about 18 in. in height, with pleasing foliage and upright spikes of pink flowers. It is a charming little shrub that usually flowers freely in June even though it has been frozen to the ground the previous winter. It has a place in low plantings, rock gardens and flower borders.

var. *alba.* Flowers white.

I. Kirilowii. Although occasionally winter-killed the branches average about 3 ft. in height, bearing pinnate leaves and attractive upright spikes of rosy flowers in June.

Lagerstroemia indica, CRAPE MYRTLE. Very popular in the southern states for its masses of crinkly pink flowers. It can be grown with fairly satisfactory results about New York City if planted in a sheltered position—it grows well trained against walls. Bloom is on growth of the current season so, even though sharply cut by frost, it may flower in late summer.

Leptodermis oblonga. A rare but attractive little shrub with upright branches of 2 or 3 ft. It has opposite dark green leaves and in the summer and fall terminal clusters of violet, tubular flowers. It makes its best growth in sunny, well-drained places.

Lonicera iberica. An outstanding species of dense, compact habit. It grows to 6 ft. or more in height and has hairy, dark green leaves. The pale yellow flowers are freely produced but they are not particularly attractive. In September and October, when few other honeysuckles are in fruit, its fat, shiny red berries are decidedly ornamental. It is a distinct species that makes a rounded specimen covered with fruits that are among the largest in the honeysuckle group.

L. Korolkowii var. *floribunda.* Few honeysuckles bloom more freely or are so attractive in flower. With slender, arching branches it forms a large spreading shrub to 10 or 12 ft. which in May is literally covered with light, rosy flowers. The foliage has a pleasing blue-gray color.

Paeonia suffruticosa, Tree Peony, is rather coarse, and totally unattractive in winter, with stiff branches, and about 4 ft. in height. The flowers, double in some forms, range from white through shades of pink and red and are large and showy. There are numerous named varieties, some of which are of exceptional beauty. Best growth is made in loamy soil in a sunny and sheltered location. The name is misleading, for the plants seldom exceed 6 ft. in height.

Petteria ramentacea is somewhat coarse, with upright branches of 6 to 8 ft., and clover-like leaves and erect clusters of showy yellow flowers in early May. It is an uncommon shrub but well worth cultivating for its bright yellow flowers.

Schisandra chinensis. An unusual vine closely related to the magnolias. It climbs to 20 ft. or more and has small, white flowers of two sexes, the female giving rise to pendulous spikes of red berries. It is not showy but it is interesting and worth growing for variety.

Schizophragma hydrangeoides. Resembles climbing hydrangea with which it is frequently confused. It is a high climbing vine that attaches itself firmly to wood or stone and has pleasing light green foliage and flat clusters of white flowers. Both vines are hardy and vigorous and very worth-while. In schizophragma the sterile flowers have but one petal-like sepal, while in climbing hydrangea there are four.

Hamamelis japonica. Bright yellow flowers in January, February or March.

Stachyurus praecox is an early flowering Asiatic shrub of distinctive character. It is of vigorous growth with stout, reddish branches to 8 ft. or so and glossy, taper-pointed leaves. Like *Pieris* its flower buds are produced in the fall and hang exposed to all the vagaries of the winter. The small, pale yellow flowers

Stachyurus praecox. Though not completely hardy here, it grows vigorously.

are carried in pendulous, spike-like clusters and open in mid-April. Though not for general use because of its lack of hardiness, it grows satisfactorily in sheltered locations and makes a good "collector's" item.

Stewartia ovata (pentagyna) var. *grandiflora.* An uncommon though handsome shrub or small tree to 10 or 15 ft. In July and August it bears large, cupped white flowers with purple filaments and though the flowers are not abundant they are always attractive. This is probably the most desirable of the stewartias.

S. Pseudo-camellia. A large shrub or small tree in the Tea Family with attractive white flowers in July and August and foliage that colors in the fall. It is not so attractive as the preceding species.

Syringa microphylla, LITTLELEAF LILAC. A spreading shrub to 7 ft. or more with slender arching branches, small leaves and small, freely produced clusters of lilac-pink flowers. The first bloom is in May but there is often a scattering of flowers on the new growth during the summer or fall. A distinct and desirable species.

Viburnum Burkwoodii, a hybrid of *V. Carlesii* and *V. utile* that originated in England in 1924. It may exceed 8 ft. in height and is more open in habit than *V. Carlesii.* Its attractive clusters of fragrant pinkish flowers open in early May and are followed by black berries. From *V. utile,* a tender evergreen species, it has inherited darker, less hairy leaves but a constitution that may not endure the winters north of New York City, although it survived the severe winter of 1933–1934 in a protected place in the Arnold Arboretum near Boston.

V. fragrans. A charming Asiatic species with stiffly upright branches to 6 ft. or more. In early April, when few other shrubs are in bloom, it opens its sweetly fragrant white or pink-tinged flowers on leafless branches. Its flowers remind one of *V. Carlesii* but the two shrubs are quite different in habit; *V. fragrans* is the more easily grown but *V. Carlesii* is the handsomer,

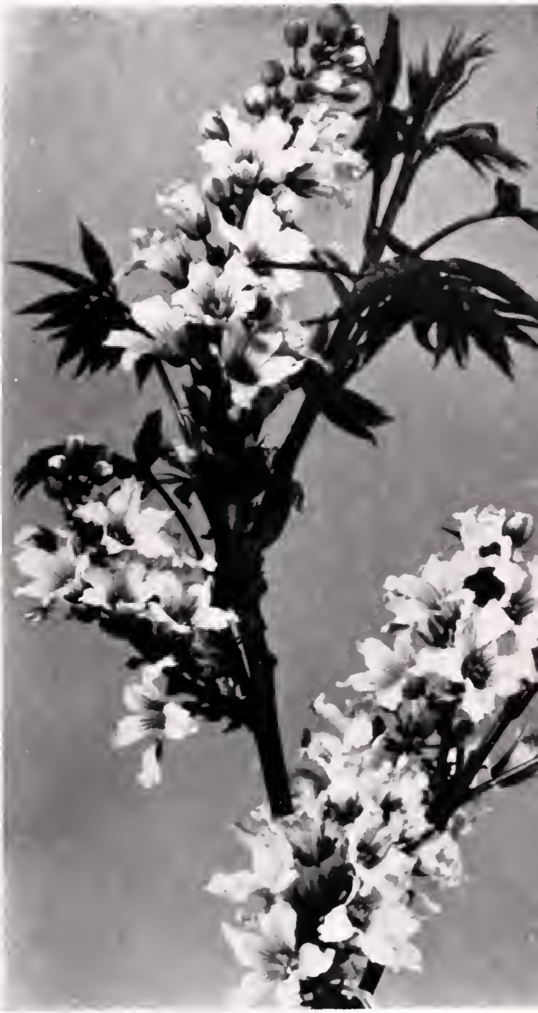
Vitex Agnus-castus, CHASTE TREE. A tall, spreading shrub to about 10 ft., with dark green palmate leaves. Growth of the current season is terminated by erect spikes of lavender flowers in July. It is not completely hardy but will usually bloom in the fall on new growth even though severely cut back. The leaves are slow to develop in spring.

var. *latifolia* (*V. macrophylla*). A vigorous form with larger and handsomer flowers and leaves.

V. Negundo var. *incisa*. Of graceful habit and grows to about 15 ft. with slender branches, deeply cut palmate leaves and lavender flowers in midsummer. Hardier than the chaste tree and of finer texture but not so effective in bloom.

Xanthoceras sorbifolium. This relative of the horse-chestnut is not widely cultivated yet it is an ornamental plant worthy of more frequent use. In Brooklyn it is a slow-growing shrub with upright branches to 10 ft. The pinnate leaves are attractive and in early May the branches are tipped with erect clusters of white flowers, each petal blotched yellow changing to red. Though smaller, the fruit resembles that of buckeye. Resistant to drought.

Other uncommon shrubs are: *Callicarpa japonica, Cotoneaster apiculata, Symplocos paniculata*, see "With Showy Berries"; *Clerodendron trichotomum*, see "Long Blooming Period"; *Daphne Burkwoodii* var. "Somerset," and *Viburnum Carlesii*, see "With Fragrant Flowers"; *Hydrangea petiolaris* and *Periploca sepium*, see "Vines"; *Sophora viciifolia*, see "For Light, Sandy Soil."



Xanthoceras sorbifolium. Appreciated by seekers of the uncommon.

* * *

How to Buy Living Plants

If you have seen a rare tree or shrub in the Botanic Garden and your nurseryman does not have it in stock, don't blame him. It is impossible for *all* nurserymen to carry material for which there is little demand. And don't give up trying to get it; just drop us a line—we may be able to refer you to a source of supply, or provide your nurseryman with propagating material if he wishes it.

WEED-KILLING CHEMICALS

Will new compounds and new techniques take over the job of weeding?

George S. Avery, Jr.

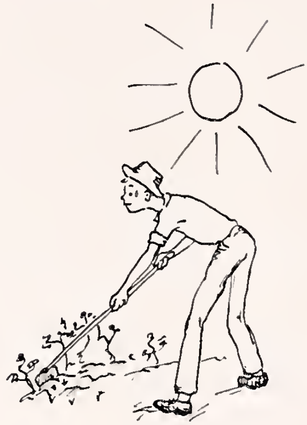
GETTING rid of weeds is a perennially interesting topic to every gardener, amateur or professional. The dream is, of course, to kill the weeds and leave the crop. For years, off and on, compounds have been marketed to kill dandelions and other pestiferous weeds. We still have most of the dandelions, but several of the so-called weed-killing compounds have disappeared from the market. Only relatively recently has the problem attracted the serious attention of researchers, as evidenced by the following approximate figures:

Years	Number of articles published
1886–1920	30
1921–25	20
1926–30	60
1931–35	90
1936–40	160
1941–42*	50

* War years, characterized by great diminution of research in many lines.

The U. S. Dept. of Agriculture, numerous State Experiment Stations, and chemical concerns now have research projects underway. Progress should continue to be rapid, in spite of the war. And justifiably so, because first class weed-killing chemicals can reduce tremendously the need for farm labor. For most of us, weeds are a problem of lawn and garden.

There are several different ways of killing weeds with chemicals. 1. Spraying the foliage with substances that will destroy them, at least temporarily, and respraying when and if new leaves appear. The object is to starve the plant, and that is what happens if it is deprived of green leaves. A solution of common salt, sprayed on, will do this, and sometimes it kills in one spraying. More often, persistent weeds are not permanently affected by it. 2. The soil may be poisoned as with sodium arsenite; four pounds in ten gallons of water has been reported to kill 90 per cent of the quack grass if applied over an area of one square rod. Heavier applications may make the soil sterile for several years. Common salt is frequently applied to the crowns of plants slated for destruction, but it, too, leaves a sterile spot of soil for a few years. 3. Spray the foliage with a toxic chemical that is absorbed by the plant, and translocated throughout its living system: the result is usually death after one spraying. Ammonium sulfamate is such a chemical. So much for the general procedures.



The ideal chemical would be one that is poisonous to weeds and not to useful plants, but this is a large order; most weeds are pretty tenacious, or they would not be called weeds. The search is therefore for potent "selective" chemicals.

A further characteristic of the ideal weed-killing chemical is that it should be non-poisonous to man and grazing animals. Few compounds are known to possess these qualifications, but here is an evaluation of those most used, or most promising. We shall hear of many new ones in the next few years. Your dealer may still be able to supply one or more of the following:

Most Used—or Most Promising

Sodium chlorate, for twenty years one of the most extensively used weed killers. It may be applied as a dry powder or as a spray, but is not selective. It is poisonous to animals, and its use may be a fire hazard under certain conditions. A proprietary compound called Atlacide is chiefly sodium chlorate, but its use is claimed not to be hazardous—as to fires. Five to 10 per cent solutions of sodium chlorate, sprayed on at the right time, will destroy most plants.

Sulfuric acid. Inexpensive grades of this acid have been widely and successfully used as weed killers, but almost exclusively in agriculture. At concentrations of 2 to 10 per cent, by volume, it is somewhat selective. *A galvanized iron spray-tank should never be used with sulfuric acid;* all-brass tanks are satisfactory. (For sulfuric acid weed control in onions, see *Cornell Exp. Station Bulletin* No. 784, 1942.)

Kerosene. Limited in its use, but reported selective and effective for dandelions in lawns.

Sodium dinitro-orthocresylate (sold under the trade name Sinox). This chemical is a coal-tar derivative (a yellow-orange dye), non-corrosive and non-poisonous at the concentrations used. It was introduced from France seven years ago, and in combination with ammonium sulfate it has proved to be fairly selective and highly effective. One per cent solutions of Sinox, sprayed on at the rate

Bindweed. Left: sprayed. Right: control.

of 1½ to 2 gallons per 1000 sq. ft., give 80 to 100 per cent control of many weeds if applied at early stages of their growth. To each gallon of diluted solution add 1½ to 3 pounds of ammonium sulfate. Wear old clothes when putting on Sinox; it stains woolens, rayon and silks. Rain as early as one hour after its application will not nullify its effectiveness. Since grasses, alfalfa, red clover, etc., are quite resistant to the spray, it has a fairly bright future as a selective weed killer. (For selective weed control in certain field crops, see *Oregon Exp. Station Bulletin* No. 403, 1942.)

Ammonium sulfamate (sold under the trade name Ammate) has become well known in the few years it has been on the market. It is applied as a spray, at a concentration of approximately 10 per cent. It is non-poisonous, but is corrosive to metal, and *spray apparatus should be thoroughly rinsed with water* immediately after using. It is not selective, but if applied carefully to weeds to be destroyed, it will not kill nearby plants. One of the important claims: it is readily translocated in the plant, so that root system and all are killed. Rain a few hours after application does not destroy its capacity to kill.

The Very Latest

Di- and *trichlorophenoxyacetic acids.* Your dealer may not yet have these: they are the newest comers to the weed killing field, 2, 4-dichlorophenoxyacetic acid (hereafter designated 2, 4-D) being better known as a synthetic plant hormone. These appear to be the first truly selective weed killers, and are effective at concentrations as low as a tenth of one per cent (0.1 per cent). Dichlorophenoxyacetic acid applied to bindweed at the Brooklyn Botanic Garden killed the weed promptly, giving the underground parts the appearance indicated in the figure. This is in full accord with the results reported in the scientific literature (*Botanical Gazette* vol. 106, pp. 232–245. December, 1944). 2, 4-D is apparently non-toxic and non-corrosive to metal spraying apparatus, and has great promise on such common garden pests as ragweed, mallow, pigweed, purslane, lamb's-quarters, etc.

The seven chemicals described above are thus far the ones that stand out. Others used with a measure of success are iron (ferrous) sulfate, ammonium thiocyanate, ammonium sulfate, etc.; these have been employed for eradication of rosette-type plants in lawns; none is equal to those first mentioned. Common borax has come into the weed killing picture lately, especially against poison ivy.

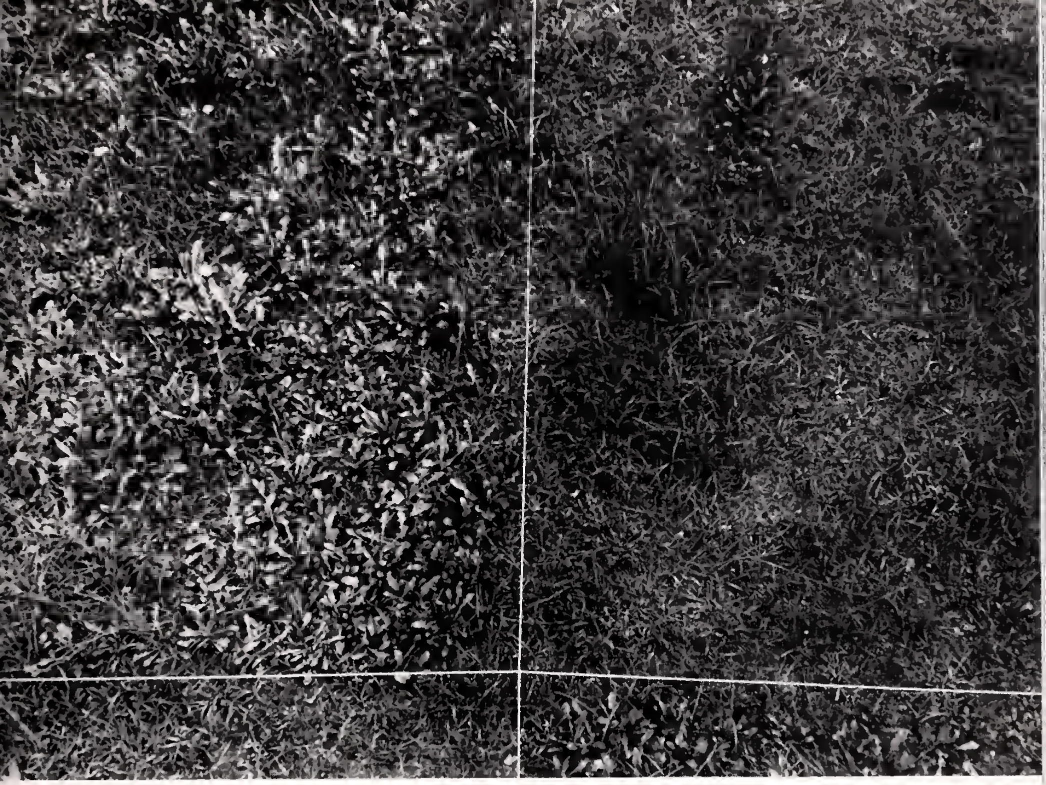
Every reader of PLANTS & GARDENS will want to know how weed killing chemicals can be used in specific situations. Lawns are probably of greatest interest, and the accompanying information on 2, 4-D is fresh from researchers.

There is one general rule that many already know of: the number of weeds persisting in lawns is inversely proportional to the acidity of the soil, i.e., the higher the acidity, the fewer the weeds (see *R. I. Exp. Station Bulletin* No. 217, 1929). This has led to the common use of bent grasses, because they thrive on acid soils. And as regards selective weed killers, don't expect a sweeping kill of all kinds of weeds with a single chemical. If it were to be that way, the grass would go the way of the weeds.

For Lawn Weeds

The interesting thing about 2, 4-D is that it either kills or makes pretty sick most of the common lawn weeds of the eastern half of the United States. Here they are:

chickweed (*Stellaria media*)
knotweed (*Polygonum aviculare*)
pigweed (*Amaranthus retroflexus*)
plantain, narrow leaf (*Plantago minor*)
round-leaved mallow (*Malva rotundifolia*)
dandelion (*Taraxacum officinale*)
shiny pennywort (*Hydrocotyle rotundifolia*)
white sweet clover (*Melilotus alba*)
broad-leaf plantain (*Plantago major*)



Eradication of dandelion from Kentucky bluegrass sod by spraying with dichlorophenoxyacetic acid at a dilution of 1:1000. Carbowax was added as a spreader, and the spray applied September 2 at the rate of 4 gallons per 1000 sq. ft. Photograph taken 24 days later. Sprayed plot at right, untreated plot at left. (Photo courtesy of Paul C. Marth and John W. Mitchell, U. S. Dept. of Agriculture.)

Many readers will not consider white clover a lawn weed, but it seems to be knocked out by 2, 4-D. The most effective chemical weeding of lawns thus far consists of spraying with about 4 gallons of 2, 4-D per 1000 sq. ft. of turf. The concentration of the chemical is unbelievably low: one-half ounce to 4 gallons of water. The investigators recommend that 2½ ounces of "Carbowax 1500" be included as a carrier and spreader. It is probable that other spreaders will prove to be as good. In tests here at the Garden we used no spreader at all, and the results were good. August and September are already established as good months for lawn treatment, but later experiments may show an earlier month to be just as satisfactory.

There are two cautions in the use of 2, 4-D on lawns. 1) Only *bluegrass* turf has been well tested; there is evidence that fescue and bent grasses are not as tolerant. 2) It is not known whether 2, 4-D has a long term bad effect on the soil.

So keep your early efforts on lawn weed eradication on an experimental scale. If your dealer cannot supply you, write us here at the Brooklyn Botanic Garden for an experimental sample. There will be a modest charge for handling and mailing.

WHY HOUSE PLANTS FAIL

What to do about it.

Montague Free

FOREWARNED is forearmed. If we know why the plants in our homes fail to thrive we can, in part at least, take steps to amend the unfavorable conditions and bring about better results.

Dry Air

The ill-health of plants cannot usually be attributed to any single cause, but probably dry air is responsible for most of our lack of success. When the air is too dry, water vapor is lost from the leaves faster than it can be replenished by the roots, the top and edges of the leaves are deprived of necessary moisture, and they die and turn brown in consequence. When this is noticed the home gardener's usual reaction is to pour more and more water on the roots, which makes matters worse by waterlogging the soil so that the roots are deprived of air, making them so unhealthy that their powers of absorption are further reduced.

The remedies are: 1) Grow plants in Wardian cases where humidity can be provided easily (more about this in a later issue). 2) Humidify the air by keeping water in the evaporating devices on radiators and in hot-air furnaces, and stand potted plants on pebbles in water-holding trays. 3) Reduce the temperature so that the relative humidity will be increased. Many tropical plants, even, which we think of as demanding high temperatures, are happier in the comparatively cool air of a bedroom than they are in the warmer but drier air of the living-room. 4) If sunny windows are available, grow desert plants such as cacti and succulents which are adapted to endure dry conditions.

Gas, Ventilation

Many plants are discommoded by impurities in the air—cooking gas, fumes from factories, and dust. Perhaps the chief reason for the success of country folk in raising plants in their homes is the comparative absence of these adverse factors.

The city dweller cannot entirely overcome these drawbacks, but it is possible to have gas leaks attended to promptly and to avoid turning on the gas before one is ready to light it. We should remember that plants are injured by gas before it is present in quantity sufficient for us to detect it. Ventilation of the room in which plants are growing is helpful provided it is done without exposing the plants to blasts of chilly air. Dust, which clogs the breathing pores in the leaves, should be removed by sponging them with lukewarm water (don't use too much elbow grease or you may injure the leaf cuticle), or by placing the plants in the bath tub once a week and spraying them with lukewarm water from the hose. This last is one of the best prophylactic measures against spider mites and insect pests, if the water is applied with some force and all parts of the plant above ground are reached.

Not Enough Light

Those who take photographs indoors know that, because of reduced light, it is necessary to use a larger diaphragm opening and give a longer exposure than when photographing outdoors. Those plants which in nature grow in full sun have great difficulty in getting along in the house because insufficient light slows down photosynthesis, the most important function of the leaves. Light is essential for all plants which have chlorophyll because it is through its action that the carbon dioxide absorbed by the leaves from the air and the water taken up by the roots is manufactured into sugar, the first organic food product.

This need for light requires that plants should be kept as close as possibile to windows, provided it can be done without setting them on an active radiator; and, if a decorative scheme demands that they be grown away from the source of light, those kinds should be chosen, such as snakeplant, Chinese evergreen, and fiddleleaf fig, which are known to be tolerant of dimly lighted situations. It has been suggested that natural light could be supplemented by growing the plants underneath a powerful electric light. There are obvious reasons why this solution might not always be practicable or desirable; and, so far as is known, it has not been demonstrated experimentally in a home that the benefits accruing from increased light are not overbalanced by the reduction in relative humidity in the vicinity of the plant, brought about by the heat from the electric light.

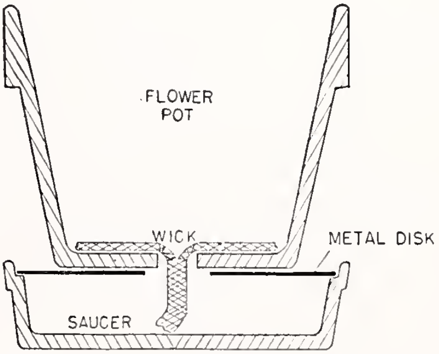
Watering

Bog and swamp plants can get along in waterlogged soil, but most plants suited to house culture demand well aerated soil. It has already been mentioned that overwatering, by driving air from the soil, makes roots unhealthy or even kills them. Watertight jardinieres are responsible for the death of many plants when, as a result of careless watering, water accumulates in them to such an extent that the pot in which the plant is growing is partially submerged. Plants displayed in containers lacking drainage holes (dish gardens, terraria) often suffer because surplus water has no means of escaping.

It has been said that "plants must be watered with brains." Certain it is that they cannot be watered by clock or calendar, for the demands of a plant for water are determined by its nature, whether or not it is actively growing, the extent to which the pot is filled by roots, the character of the weather, and the humidity of the room.

Good general rules to follow in watering are: 1) Use water the same temperature as that of the room. 2) Give water only when the soil is beginning to get dry—determined by sight, feel, and sound. (Tap the pot and if it gives a ringing sound rather than a dull thud the need for water is indicated.) 3) When watering, do a thorough job so that the earth is wet all through, even though it may require partially submerging the pot in a vessel of water for thirty minutes or so.

Making use of capillarity and conducting water to the soil by means of a wick has been suggested as a means of overcoming the difficulty of properly watering house plants. The plant is supported over a saucer of water, with a wick, preferably of glass cloth, extending from the water through the drainage hole in the bottom of the pot into the soil. The sketch shows how it is done. No coarse drainage mate-



Arrangement for wick watering

rial is needed in the bottom of the pot when using this method, and it is most easily installed when the plants are repotted, though it can be done at any time. Even with this "fool proof" device it is desirable to look at the soil once in a while and if not enough water is being supplied by the wick, supplement it by surface watering. On one occasion we successfully used this method of supplying moisture to potted plants in one of our exhibits at the International Flower Show when, because the pots had to be tilted, it was not possible to water them in the usual way. The method is fully described, with other applications, in Bulletin 793 "Automatic Watering of Greenhouse Crops," published by the Cornell Agricultural Experiment Station, to whom we are indebted for the sketch.

Insects

Attacks by insects and mites can quickly make house plants candidates for the ashcan even though growing conditions are otherwise fairly favorable. The types most likely to be bothersome are those which acquire their food and debilitate the plants by sticking their beaks into the plant tissues and sucking the sap—scale insects, mealy bugs, plant lice, etc.

One of the most effective ways of keeping the plants free from sucking insects and spider mites is to make it a regular practice to put them in the bath tub (with the drain open) once a week and spray the tops and both surfaces of the leaves with water from the bath tub sprayer. Some plants may be too large for this treatment—their leaves may be washed with a sponge dipped in soapy water. Mealy bugs on African violet, which cannot conveniently be sprayed forcefully with water, can be disposed of by making a small swab of cotton on a toothpick, dipping it in alcohol, and touching each insect. Soapy water, with or without nicotine, is effective against many plant lice (aphids). If it is inconvenient to use a sprayer, and quite often it is, mix up a bucketful of lukewarm soapy water (use up to 2 oz. of soap flakes to 1 gal.), turn the plants upside down and dip them in it.

Selection

The use of plants which are not adapted to home life results in much ill health and mortality. Many of the plants sold by florists must be looked on as transients whose decorative value in point of time does not greatly exceed that of a bouquet of cut flowers. Among these transitory plants not adapted for permanent culture in the home are: *Erica melanthera* (a S. African heath often sold as Scotch heather!), cinerarias, hydrangeas, and forced roses and bulbs. The Brooklyn Botanic Garden has from time to time published lists of plants which *are* suitable for house culture. Such lists will be sent on application to interested persons.

* * *

How to Buy Living Plants

Visit nurseries in July and August as well as in the flowering season to select stock for planting in the fall or following spring—you want to know the summer appearance of the plants you buy and the nurseryman has more time to give you attention then.

GROWING YOUR OWN

Regardless of what the food situation may be in 1945, and ignoring the desirability of lessening the strain on the transportation system by the production and consumption of home grown food on the spot, it is possible to make out a good case for maintaining your own vegetable garden at any time. First there is the opportunity it affords of raising quality products. Many of the varieties sold in vegetable stores are grown primarily for their productivity and ability to stand shipping without undue injury, rather than for their palatability. Those who have a home vegetable garden can grow lettuce of superb table quality by using varieties such as Bibb and Oakleaf which, so far as known, are never seen in stores; and can enjoy (?) Swiss chard and New Zealand spinach which, because of quick wilting, are not handled commercially. Freshness in vegetable products is appreciated by connoisseurs and at the risk of seeming hackneyed we remind you that peas and corn direct from garden, to pot, to table are infinitely preferable to shopworn specimens. And finally there is the convenience of being able to dash into the garden when unexpected guests arrive to secure the wherewithal for a meal—either salads for luncheon or beets and beans for dinner—without having to run out to the store or take a trip to the village. It is with no apologies, therefore, that the following notes on vegetables are included in Plants & Gardens.

Is a City Vegetable Garden Worth While?

The answer is "Yes," provided the plot gets at least half a day of sunshine, the soil is reasonably good and properly worked and fertilized, and water is available during dry spells.

The following crop report from a backyard city garden—20 ft. lot, houses attached—gives an idea of what may be expected. The area under actual cultivation was 15 ft. × 17 ft.

	Quantity
Beet greens	½ lb.
Beets (5 or 6 roots per bunch)	18 bunches
Cabbage, Chinese	2½ lbs.
Carrots	46 bunches
Kohlrabi	46 knobs
Leeks	40 (large)
Lettuce	14 heads
Onions	2 lbs.
Peas	1 lb. 10 oz.
Radishes	17 bunches
Scallions	1 bunch
Spinach	4¾ lbs.
Swiss chard	25½ lbs.
Tomatoes	5¾ lbs.
Tomatoes (green)	4½ lbs.
Turnip greens	5½ lbs.
Turnips	4 bunches (roots)

Chinese cabbage and tomatoes, planted too late; and peas, which require cool conditions, were the only real failures. In 1944, ambitious to have enough root crops to feed the family during the winter, a plot 12 × 18 ft. was planted on May 20th with alternate rows of Winter Keeper beets and Nantes carrots. They were set out in this way for aesthetic reasons but utility should have been the first consideration, for the carrots suffered greatly from competition with the beets, which grew so lush that they overshadowed their neighbors. They also smothered the weeds which was all to the good. Sowing was done early, because assistance was available then, but for the purpose in view it would have been better to defer planting until mid-June.

The soil was prepared by digging under the residue of soybeans grown the preceding year and fertilized with 7 lbs. of commercial fertilizer analyzing 5 per cent nitrogen, 10 per cent phosphoric acid, 10 per cent potash, with a small percentage of boron (.02 per cent); and 7 lbs. of pulverized limestone.

This plot produced more than 50 lbs. of carrots and 215 lbs. of beets—which

Leeks from a city garden

means the cook will have to devise new methods of serving beets!

Best Crops for the City Garden

Experience during the past few years has shown that the following are among the best bets for city farmers: beans, beets, leaf lettuce, onions from sets, radishes, spinach, New Zealand spinach, Swiss chard, tomatoes and turnips (foliage variety for greens). Leeks, thought by some to be a rather pernickety crop, do surprisingly well and their performance in a city garden leads one to think that specimens of exhibition quality, even, might be raised if they were given extra care.

Potatoes

The Brooklyn Botanic Garden has always taken a discouraging attitude when Victory gardeners have expressed their desire to plant white or "Irish" potatoes in the city. Past experience has shown us that the crop is disappointing under urban conditions, both quantitatively and qualitatively. In 1944 the few "hills" planted in the collection of vegetables near the model Victory Garden behaved according to Hoyle by each yielding three or four tubers the size of small walnuts.

It is a different story, however, with sweet potatoes. A single "draw" or "set" (rooted shoot) produced 24 lbs. of tuberous roots, the largest one of which weighed 5 lbs. 3 oz. These enormous potatoes were pronounced of good quality by those who ate them.

It would seem then that, on the basis of sweet potato performance here, we might tentatively recommend this crop to those city farmers who feel that they must plant potatoes of some kind. It should be remembered though that they take a good deal of room—the plant mentioned above occupied a space about 7 feet square.

For Those Who Have Both City and County Plots

Careful planning is necessary to avoid having vegetables go to waste. To this end the initial planting in the city garden should mainly be of quick maturing and city tolerant crops which can be harvested and eaten before the family leaves for the country. These kinds consist of vegetables and salads that "are good for you," such as spinach, beets for greens and Swiss chard; and radishes, lettuce and scallions. The last mentioned grow very rapidly if sets are planted. If an early spring is experienced, quick-maturing varieties of carrots, turnips and beets provide roots large enough for the table by early or mid-June. Broccoli of an early variety such as Calabrese will start to produce heads by June 1st if plants are set out early in April.

To feed the family on its return in September, carrots and beets (a winter keeping variety) should be sown about mid-June, along with rutabaga turnip. Plants of late cabbage can be set out around July 1st and bush beans can be sown in mid-July to mature in about 60 days. Leeks must be sown early in April. They will grow all summer and may be used in the fall or left outdoors all winter to provide variety in the early spring diet.

Utterly Urban—Truly Rural

Operating a vegetable garden in the city and one in the country has revealed some interesting variations in crop response to environment. Some vegetables seem to be real city slickers while others pine under urban conditions.

Sensitivity to constant heat, day and night, may possibly be a factor which affects the yield of some crops, such as peas, when grown in the city; or possibly atmospheric impurities are responsible. The difference in yield of tomatoes and sweet potatoes in favor of those grown in the city may perhaps be attributed to a longer, hotter growing season and better soil. The failure of lima beans to set their pods might perhaps be due to absence of insects which effect pollination.

While no detailed analyses have been made the general impression is that the soil in the city garden under discussion is richer than that of the one in the country, and its texture is definitely superior.

City			Country	
		Peas		
50 ft. row	7 lbs. 12 oz.		50 ft. row	25 lbs. 10 oz.
		Tomatoes		
40 ft. row	352 lbs. ripe 40 lbs. green		75 ft. row	201¼ lbs. ripe 50 lbs. green
		Lima Beans		
10 ft. row	½ lb.		25 ft. row	19½ lbs.
		Sweet Potatoes		
1 "hill"	24 lbs.		10 "hills"	25 lbs.

* * *

Anton Hubert and his harvest. Twenty-four pounds of sweet potatoes from a single hill.

* * *

HAVING TROUBLE WITH DAMPING OFF?

Various soil fungi such as *Pythium, Fusarium,* and *Rhizoctonia* are responsible for one of the worst of the gardener's headaches—"damping off" of seedlings. The trouble may occur before the seedlings appear above ground (pre-emergence damping off) or it may occur after they are up when the seedlings shrivel near the soil surface and topple over.

Sterilization of seeds and soil, plus good cultural practices—porous soil, proper temperature, abundant light and avoidance of over-watering—are ways of overcoming these pests.

Chemical dusts are obtainable at any large seed store to treat the seeds. These include copper compounds—Cuprocide, red copper oxide, etc., which, however, may be injurious to seeds belonging in the cabbage family; organic mercurcy compounds such as Semesan; and synthetics such as Spergon and Arasan. The method is to put a small pinch of the chemical in the packet of seeds, shake thoroughly, and screen off surplus powder before sowing. If sterile sand or sphagnum moss, plus a nutrient solution, is used as the starting medium no further treatment is needed.

At the Brooklyn Botanic Garden we have had good success by treating the soil with formaldehyde as follows: add 2½ tablespoons of commercial formalin to 12 tablespoons water, sprinkle over one bushel of a soil mixture of 1 part each of sand, garden soil and sifted leafmold and mix thoroughly. Fill flats with soil ready for sowing, then stack them one above the other, covering the topmost one with something to keep the fumes in, and wait 24 hours before sowing the seeds and watering thoroughly.

If more convenient, 8 ounces of formaldehyde dust containing 15 per cent commercial formalin (obtainable from seed stores) is thoroughly mixed with a bushel of soil and the seeds planted immediately. These treatments have a sterilizing effect on the seeds themselves so it is not necessary to sterilize the seeds separately. The seeds of some plants, including campanula, petunia, anchusa, lettuce and most of the cabbage family, are injured by this treatment. Wait 24 hours before sowing these.

* * *

YOU SHOULD GROW YOUR OWN IN 1945

Replacement of canned vegetables on the ration list; the news that canned goods available for civilian consumption will be reduced in 1945 as compared with 1944; the rising cost of fresh vegetables; shortages of containers for packing, are among the straws which indicate that Victory Gardeners and Canners must not relax their efforts in 1945.

The Brooklyn Botanic Garden is continuing to aid Victory Gardeners by giving courses of instruction in vegetable growing beginning February 28 and March 15. Speakers will be provided for organizations requesting their services so far as our facilities permit. As in previous years plots will be provided in the Experimental Field for men and women employees of the Botanic Garden. (In 1944, 30 employees raised sufficient vegetables for their current needs, with a goodly supply for canning and storing for winter use.) We shall carry on with the demonstration vegetable plots designed to show best methods of planning, with companion and succession crops, to get the most from the land and keep it working throughout the growing season.

WITHIN THE BROOKLYN BOTANIC GARDEN

* * *

POKE IS POISONOUS

During the past year a soldier, a German prisoner of war, was picked up on the outskirts of the City in a state of coma. Rushed to a hospital it was discovered that, among the contents of his stomach, was a piece of root, considerably mangled, about as large as the end joint of a man's thumb. The military authorities requested the Brooklyn Botanic Garden to identify this so that proper treatment might be given the patient. A "hunch" followed by microscopic examination disclosed that the root was that of pokeweed, *Phytolacca americana,* also known as poke, pokeberry, scoke and garget. The root, especially, contains narcotic poisons, and all sorts of unpleasant things can happen as a result of eating it.

Absence of full information leaves us in the position of someone who has read only the middle installment of a mystery serial: we do not know how the poke was obtained or why it was eaten—we do know that the patient recovered. From the fact that a store of the roots was found hidden in the man's bunk one can guess that he was planning to escape and contemplated living on whatever roots and herbs he was able to gather.

This fragmentary story contains a warning for addicts of pokeweed greens, who think they are an acceptable substitute for asparagus: Be careful when cutting the young shoots to reject any portion of the root; cook them thoroughly and discard the first water in which they are boiled.

* * *

"WILLIE" KELLER'S PARTY

October 11, 1944, was a great occasion for gardeners and others at the Brooklyn Botanic Garden. William Keller, who had labored long and strenuously as Conservatory Foreman in the Botanic Garden since 1915, was about to retire after a fine period of service so those who had been closely associated with him—the gardeners, the men on the grounds—decided to give him a farewell party, and what a party! Only a few people outside of that group were invited, and those few, including myself, were highly honored.

Downstairs in the potting room—and that night no one would have known it was a potting room so cunningly were the pot racks hidden with palms and flowering sprays—a U-shaped table was loaded with good things to eat and decorated with bouquets of flowers. The fine thing about all this was that no professional caterer was involved, for the salads, the ham, the beets, the pickles, and what not came from the homes of the participants.

Personally I never in my life saw so much food consumed. Everyone was happy. Mr. Free said a few graceful words, and also some other people, just enough to add a note of appreciation to the occasion but not to surfeit it with talk. "Willie" Keller, as the men lovingly speak of him, was surrounded with a ceremonious cake, with roses, with good fellowship, and went home that night happy and honored after his long service here. More power to William Keller, and may he live long and be happy!

Ellen Eddy Shaw

TEA GROWS IN BROOKLYN

and outdoors in Huntington, L. I.

Tea grows in Brooklyn, in the conservatories of the Botanic Garden where it has been pointed out to thousands of children in visiting classes. But it also grows outdoors in Huntington, L. I., which puts it in the "Man bites Dog" category for those who think of it as requiring a tropical, or at least subtropical climate. Last fall we were astonished to receive a spray of buds and blossoms from a tea plant growing on the grounds of the summer home of Mr. John C. Parker, a Trustee of the Botanic Garden. In response to a request for information about it Mr. Parker writes:

"My best recollection is that I bought three of these plants some ten years ago when they were very small . . . along with certain other supposedly tender plants. All of these were set in reasonably protected places such as one would use for the more delicate rhododendrons and azaleas, namely, northward facing slopes protected from the early morning winter sun.

As the ericaceous plants on our place have seemed extremely happy, this will tell you that the soil is light and sandy with a great deal of humus largely from the oak leaves.

I have not checked up lately on two of the three tea plants that I set out but suspect that they are gone. The one from which the spray of blossoms came is in a rough and rather open border in one of the most exposed parts of the place. It is at the south edge of a small plateau which drops sharply at the north and commands a view of Long Island Sound and the Connecticut shore. In the winter the winds from the hills of Connecticut sweep over this freely. The only favorable condition surrounding the tea plant is that it is shaded on the south by the tops of some oak trees. This plant never gets a drop of irrigation and has no protection other than the oak leaves that blow in around it. It is now about 18 inches high and a little less than 3 feet across. It is semi-evergreen and the tips of the branches are likely to burn a bit during the winter. Only once, two winters ago, was it killed to the ground but came back in vigor the next spring. [A hard winter, 1942–3! Ed.]

As the tea plant quite apparently is dwarfed by the growing conditions at Birch Hollow, I think it has little landscape value. It is, of course, amusing as a curiosity, and has high merit for clipping for table decoration in view of the beauty of the foliage and the charm of the fragrant blossoms, and more particularly of the little round white buds which it persistently produces in November every year."

❦

PERSOON'S ICONES

Through correspondence with Professor H. M. Fitzpatrick of the Department of Plant Pathology at Cornell University we have learned that the Brooklyn Botanic Garden Library possesses "the most nearly complete copy," in this country, of Persoon's *Icones Pictae Specierum Rariorum Fungorum,* a work issued in four parts in 1803, 1804, 1805 and 1808. It was published by C. H. Persoon, a pioneer in work on fungi, in order to illustrate some of the less common species described in his *Synopsis Methodica Fungorum.*

The Botanic Garden's copy lacks only the two sheets which originally accompanied the plates for the second and fourth parts. All the pages of the text and all the colored plates are present in entirety, together with the wrappers in which the work originally appeared. Though the mycological text may puzzle lay readers, the illustrations are a revelation of the combination of botanical accuracy with artistry.

A copy of Dr. Fitzpatrick's paper describing this rarity among botanical books, together with our correspondence, has been filed with the Library's copy of the Icones.

William E. Jordan

AMONG THE CONTRIBUTORS TO THIS ISSUE

George S. Avery, Jr., newly appointed Director of the Botanic Garden, formerly Professor of Botany at Connecticut College and Director of the Connecticut Arboretum—for a dozen years actively engaged in research on problems of plant growth and development.

Mary Deputy Lamson is a Landscape Architect who has designed gardens for such notables as Helen Hayes, Philip Barry, and Mrs. Dwight Morrow.

Arthur Harmount Graves, Curator of Public Instruction at the Garden, has been actively engaged in work with trees and their diseases for more than 40 years.

Henry K. Svenson is Curator of the Herbarium of the Garden and has worked extensively on problems of nomenclature, especially as they concern American plants.

Charles F. Doney, Assistant in Woody Plants at the Garden, is a Cornell graduate who has specialized in shrubs for the past ten years.

Montague Free, Horticulturist at the Botanic Garden and editor of Plants & Gardens. He conducts the Garden Guide of the *New York Sun* and is on the Editorial Board of the *Home Garden.*

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

Summer, 1945

ayout of the Small Place

—

Grass—and Lawns

—

House Plants in Summer

—

Water Gardens

—

Insect Pests and Diseases of Plants

OL. I NEW SERIES NO. 2

BROOKLYN BOTANIC GARDEN
OF
THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

Officers of the Institute

EDWARD C. BLUM
Chairman, Board of Trustees

ADRIAN VAN SINDEREN
President

WALTER H. CRITTENDEN
First Vice-President

CHARLES PRATT
Second Vice-President

SIDNEY W. DAVIDSON
Third Vice-President

EDWIN P. MAYNARD
Treasurer

JAMES E. GIBBONS
Secretary

Ex Officio Members of the Board

The Following Officials of the City of New York
THE MAYOR THE COMPTROLLER
THE COMMISSIONER OF PARKS

Botanic Garden Governing Committee

PHILIP A. BENSON, *Chairman*

MISS HILDA LOINES, *Vice-Chmn.*
EDWARD C. BLUM, *Ex officio*
WILLIAM G. CREAMER
WALTER H. CRITTENDEN
LEWIS L. FAWCETT
MRS. LEWIS W. FRANCIS
ANDREW J. GONNOUD
WALTER HAMMITT
WILLIAM T. HUNTER
EDWIN P. MAYNARD
ROBERT MOSES, *Ex officio*
ALFRED E. MUDGE
JOHN C. PARKER
DONALD G. C. SINCLAIR
ADRIAN VAN SINDEREN, *Ex officio*

Director of the Botanic Garden

GEORGE S. AVERY, JR.

PLANTS & GARDENS

Opuntia tortispina

NEW SERIES Summer, 1945 VOL. 1—NO. 2

CONTENTS

Cover .... Waterside Plants in the Rock Garden
Frontispiece .... Tropical Waterlily Pool of the Botanic Garden
Announcement .... George S. Avery, Jr. 67
Layout of the Small Place .... Harold A. Caparn 68
Grass—and Lawns .... George S. Avery, Jr. 70
House Plants in Summer .... Dorothy H. Jenkins 76
Victoria Regia .... Henry K. Svenson 78

Water Gardens:

The Garden Pool .... Henry B. Aul 84
Waterlilies .... Montague Free 88
Waterlily Classification 96
Other Aquatics and Wet Soil Plants .... Hester M. Rusk 97
The Story of Waterlilies .... Elizabeth Clarke 101
The Waterlily Way of Life .... Arthur Harmount Graves 105

Insect Pests and Diseases of Plants:

Insect Pests and Their Control .... Louis Pyenson 108
The Timing of Insect Control Operations .... R. B. Friend 113
Chemotherapy—A Method of Plant Pest Control .... E. M. Stoddard 116
Disease Control in the Home Garden .... Cynthia Westcott 119
Modern Sprays and Dusts .... L. Gordon Utter 122
Within the Brooklyn Botanic Garden 125
Heart's Desire .... Sidney Russell Tilley 126
Among the Contributors to this Issue .... Page 3 of cover

Except where otherwise noted: drawings by Maud H. Purdy, excluding those on pages 72 and 73, which are by Margaret F. Piper; photographs by Louis Buhle.

MONTAGUE FREE, *Editor*

Published quarterly at Prince and Lemon Streets, Lancaster, Pa., by the Brooklyn Botanic Garden, Brooklyn, N. Y. Entered as second-class matter, May 26, 1945, at the post-office at Lancaster, Pa., under Act of August 24, 1912. Subscription included in Botanic Garden membership dues. To others: $2.00 per year; $3.00 for two years.

Copyright, 1945, by the Brooklyn Botanic Garden.

TROPICAL WATERLILY POOL
OF THE
BOTANIC GARDEN

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
1000 WASHINGTON AVENUE
BROOKLYN 25, NEW YORK
TELEPHONE: MAIN 2-4433

Summer 1945

TO FRIENDS OF PLANTS & GARDENS:

Our first number was received with greater enthusiasm than we had dared to hope. We are glad, for we felt sure there was a place in America for just such a magazine as PLANTS & GARDENS. Your response assures us that this is so.

A word about numbers to come: this summer issue, as you are about to discover, is dedicated to water gardens. We have watched for years the interest and enjoyment of many thousands of visitors as they lingered by the lily pools here at the Garden. That is why water plants are featured in this number of PLANTS & GARDENS. We have tried to include all the "hows and whys" of water-lily culture, so you may have them in your own back yard. But there are articles by well-informed people on a number of other subjects too, including the unpleasant but timely and ever-important pests and diseases.

In the autumn number chrysanthemums will be the mainstay and the winter issue a special annual feature, our Editor's selection of the half dozen most important articles from horticultural literature of the preceding twelve months.

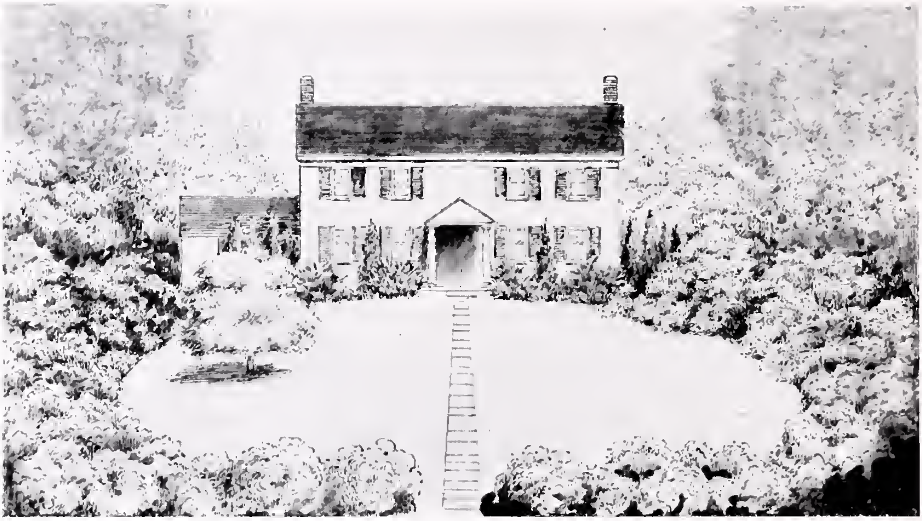
Don't overlook the continuing features. "The Layout of the small place" comes from competent landscape architects, who can help you with your planting problems. "Within the Brooklyn Botanic Garden" will, we hope, personalize the Garden for every interested reader. The autumn number will begin another continuing feature - "Hormones and Horticulture."

Enough for now. PLANTS & GARDENS is getting under way. If you like the job we are trying to do, please tell your gardening friends. Or better yet, fill out the enclosed blank and send it directly to me.

As a non-profit institution, we have almost no promotional funds, and we welcome your personal interest, suggestions and criticisms. PLANTS & GARDENS belongs to you!

Sincerely yours,

George S. Avery, Jr.
Director



An American front yard. Harold A. Caparn.

LAYOUT OF THE SMALL PLACE

Treatment of an American Front Yard

Harold A. Caparn

Landscape Architect

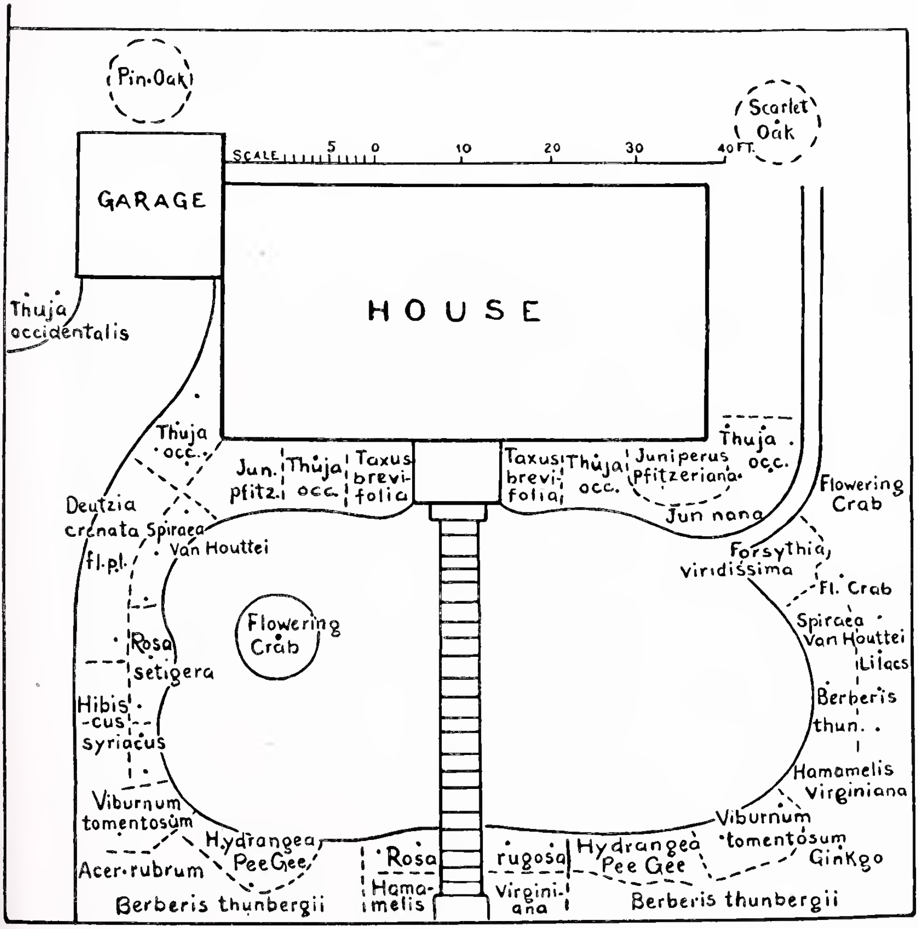
THE hundred-foot lot might be said to be the most important in suburban United States from the point of view of the designer. This is due, not only to its numbers (for there are very many more smaller lots with detached houses), but to its greatly increased opportunities for separation from the street, more and better privacy, more varied outdoor setting of lawn surface and planting, and for outdoor living generally.

Suppose we begin from the left of the picture. The garage with its large and deep opening seems to catch the eye too positively to make a pleasing impression. It is possible, but not desirable to screen it entirely; we can distract attention by putting an arborvitae or other tall narrow conifer between each of the two pairs of windows of the house, a group of arborvitae at each end of the house, and a good-sized bush, *Viburnum Carlesi* or *Symphoricarpus chenaulti*, near the house corners. Convenient places in the shrub borders might be filled in spring with bulbs—daffodils, crocus, etc. The tall, narrow arborvitaes between the windows and the two groups of arborvitaes at the corners seen from the street would make an accent and a harmonious contrast showing to advantage against the white background of the house. The entrance porch provides two deep angles in which there is a good deal of shadow during the day. This suggests conifers, of spreading rather than angular form, on each side of the porch. They should be set well away from the house and porch so that they may have room to develop and if, in the course of years, their branches extend in front of the porch line, all the better; and if they become crowded in their corners they could, without much difficulty be moved forward two or three feet.

By this time we feel that we are getting quite close to the next-door neighbor, and that both of us would like some kind of screen or visible separation of the two properties. So we repeat the treatment of the other corner of the house front with such changes as may be required by the different conditions.

So far, we have put nothing on the lawn, but have left it to do its efficient part in widening the street. However, on such a lawn one would like to see, sometimes, one small tree or large bush so placed that it would seem an essential part of the grouping—not in the center of the lawn, but separated from the grouped planting and so placed that it would mass with the foliage behind it. A magnolia, one of the smaller growing ones, with a certain amount of pruning restraint, is such a tree; or a flowering crabapple which, in time, would develop into a tree under which one could walk or sit.

Planting plan for an American front yard. Harold A. Caparn.



GRASS—AND LAWNS

Something about grasses, and how to give your lawn a good start

George S. Avery, Jr.

GRASSES cover the earth, in some six thousand different kinds. Six thousand species is a considerable number, especially when we try to think of more than a half dozen kinds we might quickly recognize. All six thousand kinds bear flowers, and they are therefore flowering plants. They belong in the same great class with palms, iris, lilies, orchids—and even onions. Their flowers are not spectacular, and many people are not really aware of the existence of grass flowers, yet tassels and ears of corn (groups of male and female flowers) are known to all.

All grass flowers are wind pollinated, and this accounts for the nuisance value of many of them, such as sweet vernal grass, which cause hay fever.

Grasses grow from the tropics to the arctic, from prairie to desert, and a few species even grow in water. They probably cover (or once covered) more square miles of the earth's surface than any other single family of plants. Our own great plains region is an example. Directly or indirectly grasses are the source of most of our food, and therefore are of considerable importance in our economy.

Without over-simplifying, we might say that there are three principal groups of grasses:

Woody grasses (bamboo)
Cereal grasses (corn, wheat, oats, etc.)
Turf grasses (pasture grasses, lawn grasses)

The cereal grasses supply the primary food for mankind, and three kinds alone have cradled the three great civilizations. Rice is still the basic food plant of the oriental peoples; Europeans had wheat, and the American Indian probably could not have survived without corn.

It must have been a very long time ago that pastoral peoples noticed how some of the forage grasses spread freely, while most others grew in bunches. The freely spreading ones that tend to be low-growing and fine-textured, are the turf grasses of today.

Now About Lawns

We are all agreed on the goal—a fine lawn. The problem is how to make one, and once made, how to keep it. Do not lose sight of the simple fact that grass is a special crop. You give special care to different things in your vegetable and flower garden, and to be successful you fertilize one or more times yearly. Yet most people plant a lawn, and just expect to mow it. Little wonder that poverty-enduring weeds soon take over. A thrifty grass plant has at least three or four linear feet of leaf blades cut from it each season. It takes well fertilized soil to keep such a plant growing; lack of fertilization is the chief reason why most people fail at lawn making. The other failures are mainly in poor or improper preparation, and the few pages that follow will tell you the hows and whys if you want to succeed as a lawn-maker and keeper. The directions apply to a temperate climate with normal rainfall. Experts and amateurs may differ in the details, but the *principles* of good grass culture are affected by neither opinion nor practice.

Grading. The main point about grading the future lawn area is to insure that water will not stand in pockets or depressions. Good surface drainage is one secret of successful lawn making, and an evenly graded lawn, without low spots scattered throughout, is decidedly pleas-

McFarland photo.

A good lawn provides an ideal setting for all types of planting.

ing to the eye. In making the rough grade, be sure to remove all sticks and stones. If the area is small, you can probably depend upon your eye to tell you when you have a smooth job, with a slight slope away from the house foundation. But if the area is large, use a string and string level. A drop of about two inches to every twenty-five feet will insure the run-off of water.

Spring. Preparation of soil. Four to six inches of good loam top soil is necessary for a first class lawn. It should be of nearly uniform depth throughout, so there will be no "poor" spots. If this is impossible, the best substitute is to put on a *very heavy* application of well rotted manure and spade or plow it under as deeply as possible. Better yet, have both the plowed-under manure and the top soil. Manure or well rotted compost are the best possible forms of organic matter. They help the soil hold moisture, and provide the necessary nutrient materials to promote plant growth. Grass roots grow down at least a foot into the soil if there is moisture and nutrients for them to go after, and a supply of organic matter deep in the soil is the best insurance you can provide against summer drought in the future lawn.

The next operation is leveling, but your soil may need lime. Do not guess at it. Send a soil sample to your state agricultural experiment station for testing, and follow their recommendations. The lime, if needed, may be put on and raked in thoroughly at the time of leveling.

Late spring or early summer. If you have finished your soil preparation and grading by late May or early June, plant buckwheat, not grass. Buckwheat, thickly seeded, raked in, and lightly rolled, will shade out most weeds in six or eight weeks of rapid growth, and put the soil in fine condition. Spade or plow it under in mid-summer, just as it starts to flower. This will add still more organic matter to your soil. The buckwheat may grow so rank that it will have to be cut with a sickle or scythe before it can be turned under.

Late summer. Rake over the newly spaded or plowed ground, and let it settle for a few weeks. If an occasional weed appears, pull it before it spreads or goes to seed. You may have to re-grade a little here and there where slight depressions have appeared.

Mid-August having arrived, it is time to sow grass seed. August though it may be, it is generally referred to as "autumn sowing."

The foregoing schedule is not the only possible good one. For reasons of your own, you may wish not to start until, say, about July 1. The manuring, plowing or spading under, and seeding with buckwheat, can be carried out satisfactorily in late June or early July. This may mean putting off the turning under of the buckwheat until the latter part of August; just be sure to do it before it starts to go to seed. The raking, partial regrading, etc., may be done early in September. If this later schedule is carried out, plan to sow grass seed *before* the middle of September. At the time of seeding rake in commercial fertilizer which any reputable concern recommends for grasses; seven or eight pounds per thousand square feet may not seem like enough, but it will give the new grass a good start. But before giving any specific directions for seeding, here are some tips upon which the success of your lawn may well depend.

The Right Seed for the Right Place

At the end of the article is a resumé of the different kinds of lawn grasses, where they grow most successfully, etc. For general purposes, however, you will do better to plant a *mixture* rather than a single kind of grass.

It is best to accept, more or less on faith, the grass seed mixtures offered by reputable seed houses. No good seedsman can afford to sell an inferior product, and if you want a good lawn, you can't afford to buy cheap seed. If your future lawn is relatively flat, and gets sunlight half of the day, or more, any good standard mixture should serve you well. But if you have special conditions, plant one or more special purpose grasses to cope with them. For example, if part of your area is shaded, be sure to plant a "shade mixture." And if you are planting on a hillside or steep terrace, you should buy a special mixture for this, too. Some firms also offer mixtures that do better-than-average under seashore conditions, etc. The point is to choose the seed for the situation, and if you have a variety of conditions, don't plant one mixture and expect it to thrive everywhere.

Now a word about what goes into a good grass seed mixture. Some species of grasses make a quick start, and look well for a season or two. They prevent the soil from washing, and give protection to the slower growing species in the mixture. For this reason they are referred to as "nurse" grasses. The slower-growing species in the mixture, often the finer-textured grasses, are the so-called "base" grasses. With proper care the latter live on more or less indefinitely, and make up the permanent lawn. The nurse grasses tend to disappear.

You may want to go in for a single species of grass rather than a mixture. If so, and if it means doing over an old lawn, you had better experiment with plots of three or four kinds of grasses to see which does best in your situation. Golf greens are most everyone's ideal in a lawn. Do not shoot so high in the beginning. The "bent" grasses used in golf greens make fine lawns, but to have a pure stand of bent grass means a great deal of very special care. Be content for now with the ten to thirty per cent of bent which will come in your grass seed mixture.

Seeding

Between the middle of August and mid-September (the earlier the better), sow four to five pounds of mixed seed per thousand square feet—with a seeder, if you own or can borrow one. If you sow by hand, count on eight to ten pounds for the same area. Sow at a time of day when there is little or no wind, and rake over very lightly. Grass seed planted one-eighth inch deep, or less, will do much better than deeper planting. Tiny grass seeds if planted much more than one-eighth inch deep, are literally buried. Roll lightly after raking over the newly seeded ground. If there is a reasonably good prospect of rain within a week or two after planting, it is better not to water with the hose.

When to Mow

When the new grass is about three inches high, roll lightly, and mow a day or so later. Set the mower to cut at a height of about one and one-half inches. Whether or not to catch grass clippings is a perennial question. If you are willing to mow frequently in periods when the grass grows rapidly, so the clippings will be short and inconspicuous, it is better to let the clippings fall back on the lawn. They act as a mulch, and undoubtedly help somewhat in preventing loss of soil moisture. On the other hand, if a lawn is well fertilized with plenty of organic matter mixed with the soil, it is not very apt to dry out anyway—at least in years with ordinary rainfall.

If you want a lawn that will always appear clean and free from the dried grass clippings, there is no alternative to the catcher. Grass clippings need not be wasted. They are fine for your compost heap, particularly if free from weed seed.

Watering

A well-fertilized lawn, with ample humus worked into the underlying soil, needs little watering except in unusually dry years. Some people water their lawns more or less by habit, rather than by need. If your lawn shows signs of drying out, give it several hours soaking with a slow running hose. Once each week or ten days ought to be ample, even in dry spells. Prolonged dry spells are another matter, and may require more frequent watering.

Weeds

In the last issue of PLANTS & GARDENS there was an article on weed control. It summarized recent research on the new selective weed killer called "2-4-D." Experiments are being conducted here at the Garden this summer on chemical weed control in lawns, and we will keep you informed from time to time of our progress. Meanwhile, your autumn-sown lawn should give you little weed trouble. If you make it a point to take out the first few weeds by hand, whether they appear the first autumn or the next spring, you will be surprised how rapidly the grass will fill in, and how it will tend to choke out the weeds.

High Lights

A good lawn depends primarily on good preparation—like everything else. Your grass has to live and grow in the soil you prepare for it. If you want it to keep on growing, the soil must be fertile, and must be kept fertile by spring and fall application of a good lawn fertilizer. Use manure in preparing the seed bed, but do not use it as a top-dressing after your lawn is established; it makes a wonderful top-dressing, but will leave you thousands of new weed visitors. (Sterilized sheep or cow manure are satisfactory; they are weed free.) Autumn seeding with a good grass mixture means that your grass has two growing periods to get ready for the hardships of summer, the fall you seed it, and the following spring. Most kinds of lawn grass are temperate climate species, and their all-important root growth occurs to the greatest extent during the cooler seasons of the year. Prepare well, and your lawn will be a never ending source of satisfaction.

Lawn grass "formulas" and why they contain the grasses they do

The following are modifications of Cornell and New Jersey Agricultural Experiment Station mixtures. They are illustrative of the make-up of lawn mixtures.

General purpose mixtures

I

	Per cent
Kentucky Bluegrass	50
Rough Bluegrass	15
Rhode Island Bent (Colonial Bent)	15
Creeping Red Fescue	15
White Clover (if desired)	5
	100

II

Kentucky Bluegrass	50
Red Top	25
Rhode Island Bent	10
Perennial Ryegrass	10
White Clover (if desired)	5
	100

Mixture for shaded areas

Chewings Red Fescue (or Creeping Red F.)	20
Kentucky Bluegrass	25
Rough Bluegrass	30
Velvet Bent	15
Red Top	10
	100

Mixture for poor or sandy soils

Chewings Red Fescue (or Creeping Red F.)	35
Red Top	20
Rhode Island Bent	15
Kentucky Bluegrass	10
Perennial Ryegrass	15
White Clover (if desired)	5
	100

Here are a few facts you will want to know about the grasses mentioned in the foregoing mixtures.

Nurse Grasses

Red Top (*Agrostis alba*). This is one of the best nurse grasses; 4½ million seeds to the pound. It is fine-textured the first year, but will not withstand close mowing. Becomes coarse and stubby after the first year, and generally disappears from the turf after two or three years. It is not very choosey as to soil type, or moisture conditions, but does somewhat better in sun than in shade. Planted for its effect in the beginning ("nurse grass"), its longer range characteristics matter little.

Perennial Ryegrass (*Lolium perenne*). Often called English Ryegrass. A good nurse grass, but much coarser than Red Top; 300 thousand seeds to the pound. If planted thickly, will crowd out permanent grasses; disappears from the turf after two or three years. It, like Red Top, tolerates a wide range of growing conditions.

Permanent Grasses

Kentucky Bluegrass (*Poa pratensis*). This is the base grass for many of the mixtures offered on the market; 2½ million seeds to the pound. It is fine-textured and spreads slowly by underground creeping stems. It thrives in sun or shade on fertile soil (slightly acid to alkaline) and is quite tolerant of drought.

Rough Bluegrass (*Poa trivialis*). Sometimes called "Rough-stalked meadow grass," but is actually finer-textured than Kentucky Blue; 2¼ million seeds to the pound. It spreads by runners, above ground; on fertile soil (neutral to slightly alkaline) will give a good account of itself, particularly in shade. It is not drought resistant.

Chewings Red Fescue (*Festuca rubra* var. fallax). A deep rooting grass, hence especially good for slopes and terraces; 600 thousand seeds to the pound. It is a bristly and sharp, wire-like grass, and gets along famously on infertile acid sandy soil—or even on sandy good soil. It is drought tolerant, but intolerant of moisture. Sun or shade are to its liking. Spreads by tillering.

Creeping Red Fescue (*Festuca rubra* var. stolonifera). Has most of the characteristics of Chewings Fescue, but the further advantage of spreading by underground creeping stems; 600 thousand seeds to the pound. A decidedly valuable ingredient for mixtures to be planted on infertile sandy soils.

Colonial Bent (Rhode Island, Astoria, and other varieties) (*Agrostis tenuis*), 7 million seeds to the pound. All the bent grasses are fine-textured; and prefer fertile, slightly acid soil. Mowed closely, and given the attention of the expert, they are the grasses of the golf green. With the attention of the amateur they are excellent grasses for the ordinary lawn, and a valuable component of any good mixture. If you have a seeder, two pounds of bent grass per thousand square feet is an adequate seeding (more seeds per pound!). Colonial Bent is not drought tolerant, and requires a half-day or more of full sun. It spreads chiefly by underground creeping stems.

Velvet Bent (*Agrostis canina*). Several varieties—Piper, Raritan, and others; 10 million seeds to the pound. In addition to the general characteristics and soil requirements of the bent grasses, it is drought resistant, and is the only bent to thrive in shade as well as sun; some strains are reported highly resistant to disease (more about grass diseases another time). It spreads by both under and above ground creeping stems.

If you live within commuting distance, plan to spend a little time in the Brooklyn Botanic Garden grass demonstration plots. You will find them enlightening as to *kinds* of grasses, and lawn weed control. You will also see "Flawn," a new-comer for American lawns. More about it in PLANTS & GARDENS later.

* * *

HOUSE PLANTS IN SUMMER

Thoughtful care given to house plants in summer pays dividends in healthier stock in fall

Dorothy H. Jenkins

Garden Editor, The New York Times

The traditional summer vacation is as essential for house plants as it is for people. Whether it be shrub, perennial or bulb, no plant can be expected to look its best twelve months of the year. The period when house plants are least needed, fortunately, coincides with the months when our gardens are most prolific of bloom. Thus cut-flowers supply our homes with garden beauty while house plants store up vigor to take over the job when frost comes.

One day in May when the rain finally stopped and the wind became a balmy breeze, the house plants undoubtedly were removed from their indoor quarters to a sheltered spot in the garden.

Every garden should have a small spreading tree or a large arching shrub as a summer haven for house plants. Plants can be arranged under them according to their greediness for sunlight. Green-leaved foliage plants belong near the trunk where shade is deepest. Farther out under the branches, yet in some shade, place the flowering plants such as azaleas and gardenias, sweet olive and plumbago. Poinsettia, young geraniums and common flowering begonias belong under the outer circle of branches where they receive sunlight but are protected from its full summer strength.

House plants put out to pasture are not fully able to take care of themselves. They may subsist but are not likely to be rejuvenated unless they are watered faithfully whenever they need it. Usually this means a thorough soaking of the soil in the pot and the soil around it about once a week. It is very easy when flourishing a hose to think that a light shower will suffice for watering, but time should be taken to see that moisture goes where it is needed in sufficient quantity.

Watering house plants with a hose is easier than the teakettle or watering-can method indoors. It should be accompanied by a forceful, close-up spray of the foliage, so that insect pests will have little chance to obtain a foothold. The junction of leaf and stem (axil) as well as the underside of the leaves should have special attention.

In spite of routine hosing and healthy outdoor air, some house plants will come down with an attack of insects. Aphids, red spiders, scale and, infrequently, mildew may appear. Then a spray of nicotine or Volck against the insects; and dusting the spider mites and mildew with sulfur is in order.

House plants with pots buried in soil. Note drainage beneath pots.

Pruning is the third phase of summer care. Generally speaking, it may amount to no more than pinching out a shoot tip, or heading in an exuberant side branch, for shapely plants in the winter dress parade.

If house plants were repotted last May in freshly mixed soil or the surface top-dressed, fertilizing is not necessary for most of them during their vacation time. But extra feeding ought to start for a few which are greedy or make a stupendous flower display. Christmas cherries, orange and lemon trees, which should be bearing colorful fruit by early winter, need stimulation in summer. So also do such plants as hydrangea and gardenia in order to store up energy for their showy bloom. Use dilute liquid manure or commercial fertilizer in water every two to four weeks, starting in August.

House plants are not really as much care as the tale of watering, spraying, pruning and fertilizing might imply. Once properly settled under their sheltering tree, most can be forgotten, save for thirty to sixty minutes each week, from June until September.

Some house plants, of course, progress no farther than the porch. Because of possible damage to their woolly leaves, African violets and gloxinias carry on there.

The window with its bracket for *Cissus antarctica* would look bare without it, and some of the other foliage plants which do not seem to care whether they are indoors or out are repotted in spring if this seems desirable and then returned to their location or the porch. Thin leaved caladiums with fascinating colorings and markings help to relieve the boredom of old winter plants and are a refreshing fill-in for any yawning spaces left on deep window sills or bookcases by the true house plant exodus.

Late August is none too early to be up and doing about bloom indoors during winter. Baby callas may be started for Christmas bloom. Long stems of ivy adapt themselves better to indoor conditions if cut before September 1 and left in a vessel of water on the porch until they are wanted.

Seeds of black-eyed Susan vine (*Thunbergia alata*), planted five to a three-inch pot and thinned to three seedlings, will start to flower in January and maintain a succession of flowers until the following June. Self-sown annuals such as snapdragon and cosmos and small marigold plants may be potted for autumn bloom in a sunny window.

Geranium and begonia cuttings and any made from foliage plants last May are undoubtedly ready for potting by this time. But geraniums which have been flowering in a window box all summer are not possibilities for the winter window. A little later they may be pruned back severely for cuttings and the cut-back plants brought along to start flowering again late next winter. But no matter how flourishing it looks in September, no geranium can be expected to blossom uninterruptedly throughout the winter.

Moving plants out too early in spring is matched by postponing the move back too late in the fall. Memorial Day and Labor Day are easy deadlines to remember any year. There will be no trouble or extra work attached to the return if a three-inch layer of cinders or gravel was spread under each pot before it was sunk to its rim in the ground. If this was forgotten in the spring rush, midsummer is not too late to correct the omission. Even though the day is warm, the time is well spent in lifting the plants and replacing them, for the loose material prevents expansive roots from anchoring the pot too firmly in the ground and guards against the entry of earthworms.

House plants are the least of a gardener's worries during summer, and their routine care painless though not to be forgotten. Once the invigorated plants in freshly scrubbed pots have been brought back indoors, they are as welcome a sight as the greening of the lawn in spring.

VICTORIA REGIA

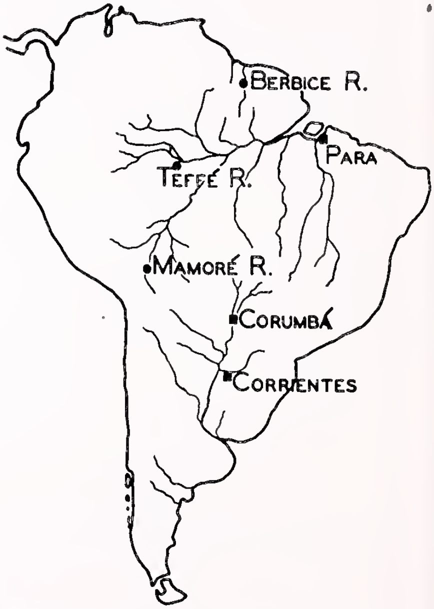
The story of the giant waterlily

Henry K. Svenson

THE Amazon waterlily (*Victoria regia*) is an amazing plant, and it vies with the East Indian *Rafflesia* * as perhaps the greatest curiosity in the plant kingdom. Robert Schomburck, the great explorer of British Guiana, saw it in the Berbice River and sent specimens and figures to England, and the flower was dedicated by Lindley (Dr. John Lindley, a famous botanist of Victorian days) to Queen Victoria, as the name implies. To give an idea of this waterlily, one can do no better than to quote a part of Schomburck's account, which is given in Edward's *Botanical Register* (1838). "We arrived at a point where the river expanded, and formed a currentless basin; some object on the southern extremity of this basin attracted my attention; it was impossible to form any idea what it could be, and animating the crew to increase the rate of their paddling, we were shortly afterwards opposite the object which had raised my curiosity—a vegetable wonder! . . . a gigantic leaf from five to six feet in diameter, salver-shaped, with a broad rim; of a light green above, and a vivid crimson below, resting upon the water. Quite in character with the wonderful leaf was the luxuriant flower, consisting of many hundred petals, passing in alternate tints from pure white to rose and pink. The smooth water was covered with the blossoms, and as I rowed from one to the other I always observed something new to admire."

The account by Malme in the Acta Horti Bergiani (1907), published by the Botanical Garden of Stockholm, gives us the differences between *Victoria regia* and *Victoria Cruziana*. It is much superior to other discussions and we have used the information freely in this article.

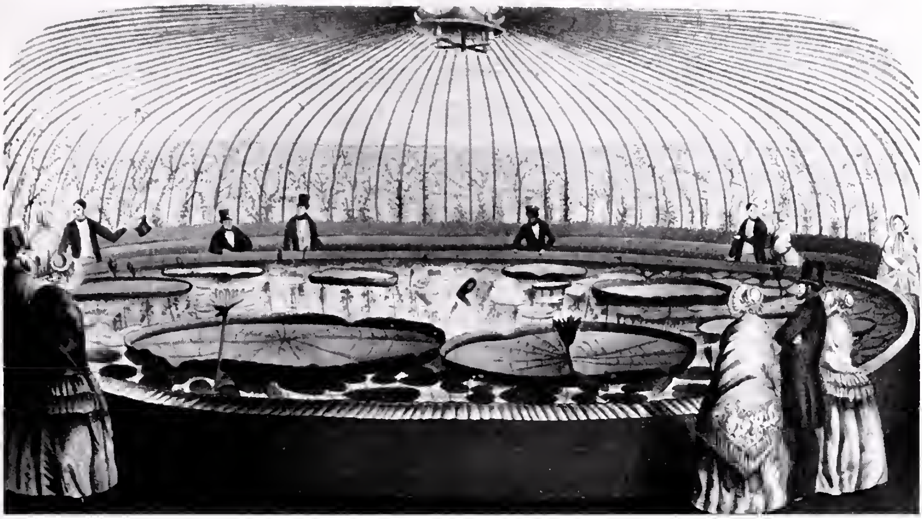
Victoria grows from British Guiana to Corrientes at the boundary between Paraguay and Argentina, and from Para at the mouth of the Amazon to the lowlands of Bolivia. Not till 300 years after the discovery of South America did plants get to Europe, due to the fact that they occur in quiet bays and lagoons in the rivers, and are often hidden by brush and swamps. Many eminent explorers of the region where it grows have never seen the plant.



Map showing locations for *Victoria regia* and *V. cruziana*, mentioned in text.

---

* [A parasitic genus belonging in a family all its own—*Rafflesiaceae*—one species of which, *R. Arnoldii*, has flowers 3 ft across. Ed.]



Reproduction of lithograph showing *Victoria* growing in the establishment of Van Houtt in Belgium. From Flore des Serres, Vol. VII, 1851.

The Austrian botanist, Thaddeus Haenke, apparently was the first European naturalist to see the plant. He never returned to Europe, and left no actual description, and his knowledge was left to us quite by accident. When D'Orbigny, the French explorer, visited the Bolivian lowlands in 1832, he met a missionary who in 1800 or 1810 had gone with Haenke to the river Mamoré. There they found a water lily evidently the same as D'Orbigny had seen at Corrientes in Argentina in 1827. Bonpland (1819) had also seen the plant at Corrientes, but his observations too, were forgotten.

By 1840 the Victoria was known in Europe. In 1832, Poeppig had found it at the mouth of the river Teffé, a tributary of the Amazon, and described it under the name *Euryale amazonica,* but his description was so short that it is still doubtful exactly what species he had. In 1837 Robert Schomburck, as we have mentioned, found the plant in British Guiana.

D'Orbigny described the plant which he found at Corrientes as a new species, *Victoria Cruziana,* named for General Santa Cruz, with whom he made extensive explorations in Bolivia. He differentiated the two species chiefly on flower color and lack of pubescence on the lower surface of the leaf, but these characters are extremely variable.

Knowledge of *Victoria regia* was quite different in 1853. Early attempts to bring back living plants to Europe were unsuccessful, for the roots rotted during the voyage. Dried seeds failed to germinate. Two seeds germinated from the shipment which Bridges made in damp earth, from Santa Ana in Bolivia in 1846, but the plants soon died. Not until 1849 did seeds sent by two English physicians in Georgetown, British Guiana, successfully germinate and flower at Chatsworth, the seat of the Duke of Devonshire. The next year they were grown by Van Houtte in Belgium, and soon nearly everywhere in the civilized world. At the Royal Botanic Gardens, Kew, a greenhouse was built solely to accommodate *Victoria regia*. In the United States plants flowered in Philadelphia in the garden of Caleb Cope in 1851, and John F. Allen (1854) published colored illustrations—almost life size—of plants grown at Salem, Massachusetts.

V. Cruziana, on the other hand, was for a long time imperfectly known. Malme in 1894, collected a *Victoria* at Corumbá in Matto Grosso, at the headwaters of the Paraguay River, but since he believed the plants to be ordinary *Victoria regia* he did not bring back living material. Passing through Rotterdam on his way home he saw that the specimens of *Victoria regia* had a different margin from the plants he had seen in Matto Grosso and realized that his plants were *V. Cruziana*.

In 1902 Malme again visited Corumbá, to bring back living material to the botanical garden at Stockholm. He found the lagoon dried up, but learned that plants were available at Bahia Blanca, some distance away. Arriving at this place, he found an outburst of tropical fever, and did not dare to venture out to the Victoria region. On his way home he stopped at Corumbá, and managed to get two ripe fruits. The seeds were kept moistened in a glass jar, germinated well, and the plants flowered in 1904. *Victoria regia* was grown in the same pool, and the differences could be readily observed. The leaf-edge of *V. regia* is outwardly bent, while that of *V. Cruziana* for over half the height is bent inwardly, somewhat constricted in the middle and then turned outward.

Henkel in Darmstadt (1904) sold a new form of Victoria. He got seeds from Tricker, who had obtained them from Corrientes in Argentina. This is typical *V. Cruziana*.

In general organization *V. Cruziana* resembles *V. regia*, but differences can be seen even in the young plants. In *V. regia* the leaves are smooth or merely pubescent below; in *V. Cruziana* they are villous with 8–10 cells, as compared with the 4–6 cells in *V. regia*. In *V. Cruziana* the base of the spines is very fleshy, often compressed from the sides, and the larger thorns are fleshy to the middle, and contract suddenly to a small sharp point; the spines of *V. regia* taper gradually from the small cylindrical base which is soft and fleshy only at the very bottom. In general the thorns are shorter in *V. Cruziana*, but now and then may reach a length of 18 mm.

The Victorias are night-blooming, each flower lasting for two nights. The flower begins to open in the evening, about 6 o'clock. By nine, the sepals have become horizontal. They are white on the inside with pale purplish streaks. By midnight the flower has unfolded, and no further growth takes place.

About nine o'clock on the following morning the petals, especially the inner ones, begin to change color and become rosy red and the flower closes about midmorning. Again in the late afternoon the flower begins to open. About 6 o'clock the petals are about the same as at midnight but have loosened somewhat so that the outermost hang down. They are now more or less purplish-red in color, darkest toward the base. By 9 o'clock most of the stamens have taken an upright position, with the anthers bent outwardly. The innermost stamens always remain turned to the center. About 3 in the afternoon of the second day the sepals and the outer petals, which are now a beautiful purplish red, raise themselves and close up, and the flower begins to sink beneath the water.

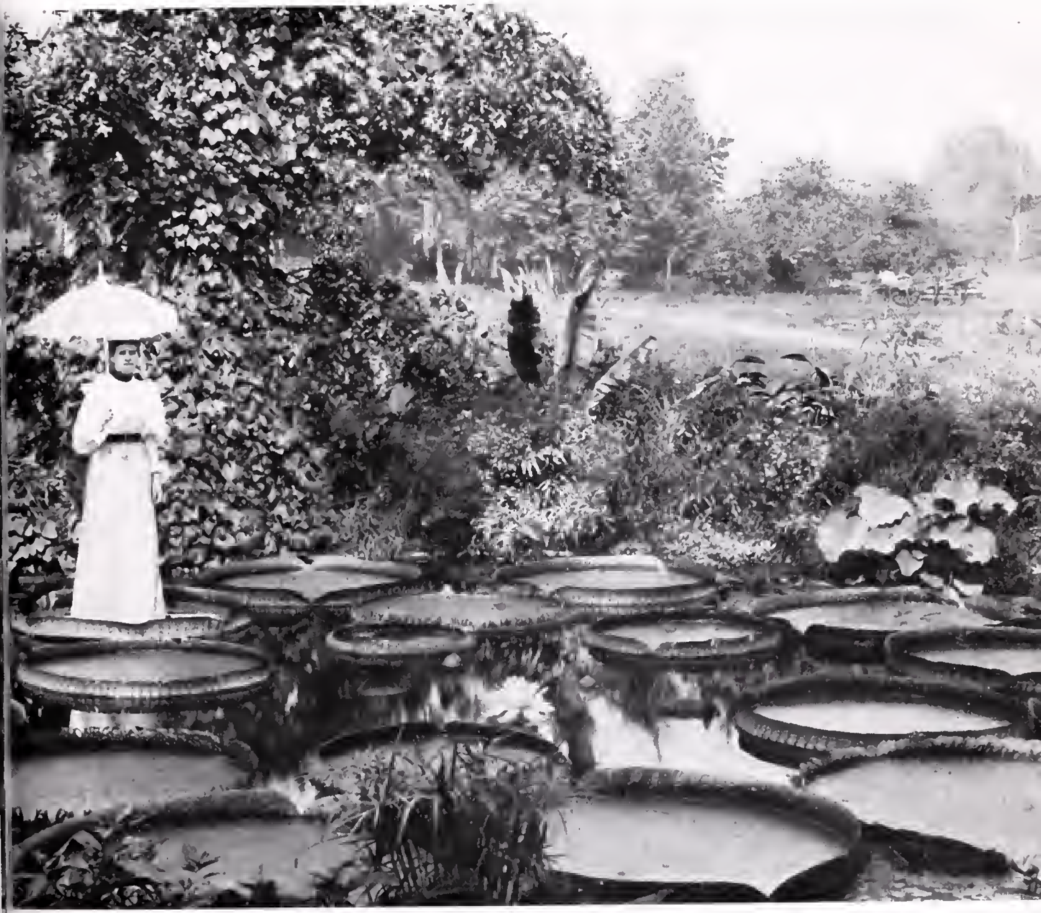
The enormous leaves are armed beneath with formidable spines and reinforced with a network of veins, some of them projecting more than an inch from the surface.

In addition to its ornamental interest the plant has some uses. The seeds are ground up into flour by the natives and called "water maize." The enormous size of the leaves, large enough to support a woman, made the plant a subject for experiments on the rate of growth of leaves. Such experiments were carried out by Drude (1880) who rigged up intricate apparatus to measure the growth, every half hour, from the center of the leaf to the circumference, and also the lengthening of the leaf stalks. Sources of error, due to movements of the leaf in the water and the effects of temperature and moisture on the apparatus could not be wholly controlled. He found that the leaf had its greatest growth at the time of cooler water or more intense darkness from 12:30 to 3 A.M. and that the most intense growth (about ⅜ inch) occurred from 12:30 to 1 A.M. It has been stated that the leaf surface may increase 4 or 5 square feet in twenty-four hours.

* * *

Victoria Cruziana growing at the original establishment of William Tricker & Co., Clifton, N. J. in 1894.

S. C. Nash photo.



CULTURE OF VICTORIA

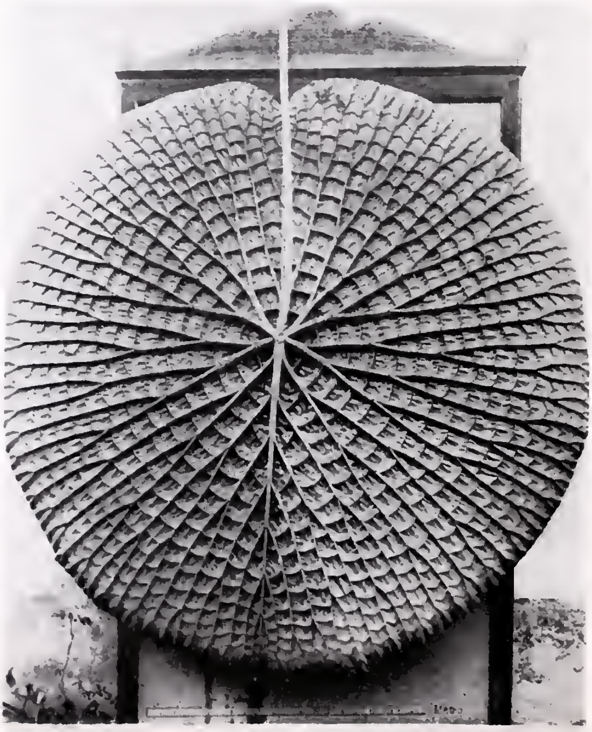
The spectacular Victoria while it invariably excites great interest is not likely to be seen growing in everybody's water garden—it demands too much space and too much rich soil.

V. Cruziana (*Trickeri*) seems to be more amenable to cold in the North than the one known as *V. regia,* doubtless because it originates farther from the equator—the head waters of the Paraguay River and extending as far south as Corrientes in Argentina. For northern culture the seeds must be started in February or early March in a warm sunny greenhouse (water temperature 85°–90° for *V. regia*; 65°–70° for *V. Cruziana*). Because we do not have tank facilities in a greenhouse with the correct temperature and aspect we have come to rely on the generosity of William Tricker, Inc. for planting stock of Victoria and tropical waterlilies in general. [ED.]

VICTORIA'S VEINS!

The network of veins shown in the picture of the leaf of Victoria makes one wonder how long they would be if placed end to end. Apart from those which are clearly visible there are still others discernible only with the aid of a microscope and special laboratory methods. So far as known the "mileage" of veins in a Victoria leaf has never been worked out, but careful studies on large tobacco leaves (about 2 sq. ft.), 1/14 the size of Victoria (about 28 sq. ft.), have revealed well over 4,000 feet of veins—nearly a mile!

Underside of leaf of *Victoria* showing spines and network of veins.



Iris Kaempferi in Jenkins Pool of the Garden.

Water Gardens

Discussing the garden use of aquatics and moisture-loving plants

WATER in pond, brook, or river seems to fascinate human beings of all ages. In youth, hours are spent getting happily wet and dirty, in fishing and investigating the interesting animal life that congregates in and around pools. In maturity our interest takes a more sedate form and there are many who get great pleasure from gardening in pool, brook, or bog.

A pond suitably planted with waterlilies and similar aquatics, with a few tall-growing water plants such as East Indian lotus and perhaps cat-tails to break the flatness is more interesting because of the insect life attracted to it—dragon flies for example—and more beautiful because of the vegetation.

While a natural water feature is a distinct asset its absence does not prohibit water gardening; neither is it necessary to spend large sums on the construction of an artificial pool. Discarded laundry tubs have been used very effectively for the culture of water plants. Half-barrels sunk in the ground and supplied with soil and water can accommodate the smaller-growing pond lilies, while moisture-loving plants can be set around their margins. Dealers in water plants can supply, in normal times, prefabricated pools which need only to be set in an excavation and water supplied. Those who want something larger can perhaps dam a small stream, while if a more elaborate pool is needed that will harmonize with the architectural features of the house it can be constructed of concrete or masonry to fit the locale.

The use of plants which thrive in wet ground offers opportunity for enhancing the beauty of a meandering stream; or for transforming a swampy area into a gardened spot without the trouble and expense of installing artificial drains.

There will be found on the following pages a discussion of the garden pool as a feature in the landscape; a description of methods of growing waterlilies and waterside plants; an account of that marvel of the plant kingdom, the giant waterlily; evidence that the fascinating flowers of waterlilies have intrigued the mind of man from time immemorial; examples of the inspiration they have afforded to artists and craftsmen; and an account of the "way of life" of the waterlilies.

THE GARDEN POOL

Must be carefully placed and in harmony with its surroundings

Henry B. Aul

Landscape Architect

If you have a pool it is likely to be one of the first things noticed upon entering the garden, and interest in such a feature is quite certain to be sustained. For this reason careful consideration should be given to the type and location. In the informal garden, the pool should be in keeping with its natural surroundings. We frequently fail to attain this harmony with a pool too formal in type. Both the pool and the remainder of the garden may be satisfactory in themselves, but combined neither helps the other to make a unified, pleasing composition.

In the informal garden the simplicity and harmony of the natural landscape are qualities to be striven for, not great variety. For the same reasons that you would not furnish a rustic hunting lodge with Sheraton pieces, you should not have a square, rectangular or other formal shaped pool of brick, cut stone or concrete, located in the middle of the naturalistic garden.

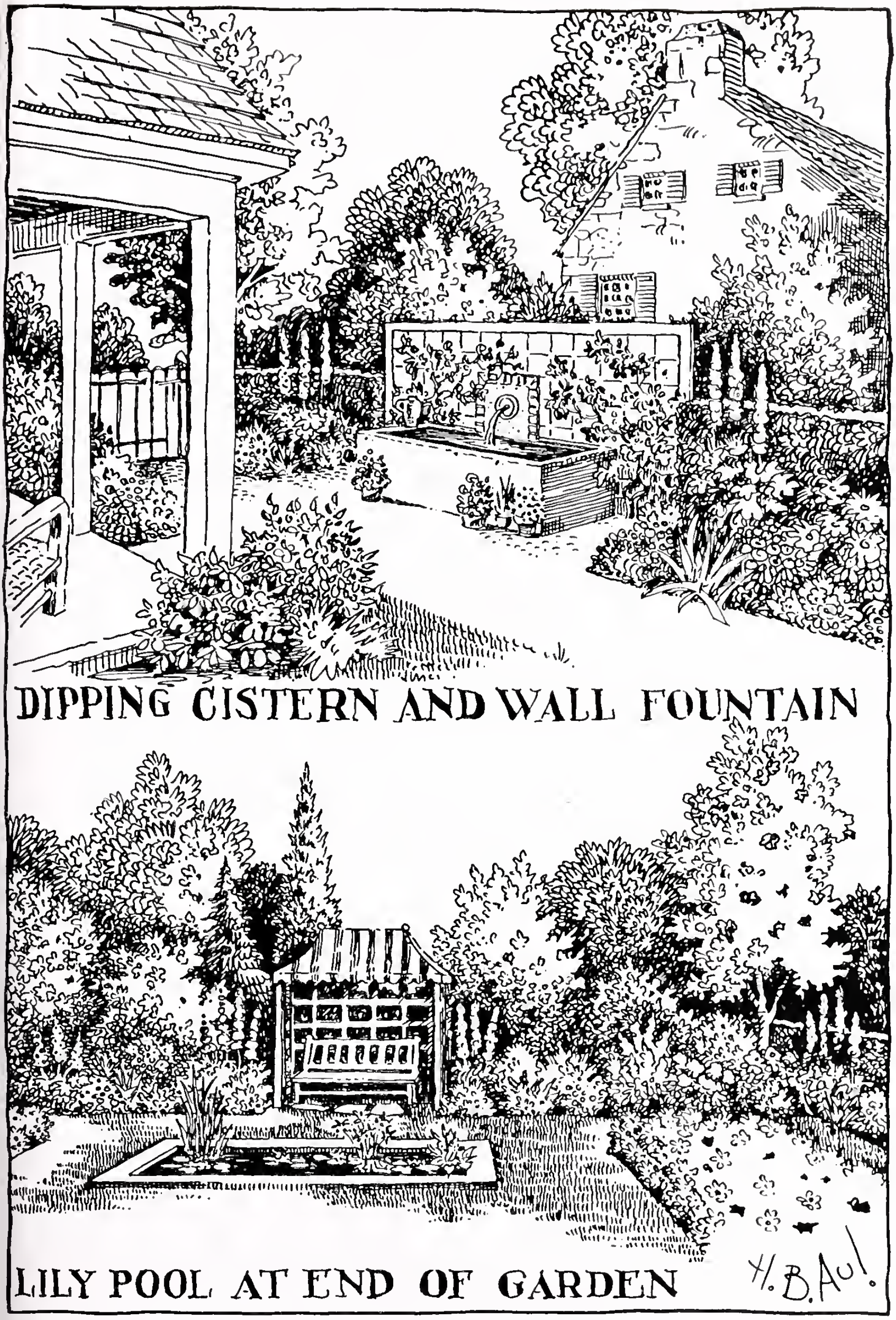
The pool should follow the informal shape of the pond as it is found in natural landscapes, albeit on a much reduced scale. It may be edged with a coping of flat, natural looking stones, but never with stones standing on end, for these will attract too much attention to themselves. The turf and planting may come right up to the water's edge with no stone, or just an occasional group of stones cropping out of the waterside planting.

The water and pool in general will appear more logically located in a hollow or slightly lower level than the surrounding garden. Perhaps the ideal situation is one where a slightly lower spot of ground adjoins a higher sloping bank on one side. The natural pool will look at home here, tucked low against the side of the slope amidst its companion planting and possible outcropping of rocks. It should not be completely planted around, with no place where one may walk to the water's edge, but it may be greatly enhanced by occasional enframing planting. If there is to be a waterfall it will need an ample background of stones and planting.

It may be argued that because the pool is such an interesting feature in itself it is self-sufficient regardless of its surroundings, and it is true that we are quite likely to allow the pool, as a medium for growing water plants and as a place to keep goldfish, to overshadow its greater value and larger function in the whole design of the garden. In short, seeing only the pool, we miss the larger picture of the garden with the pool as a main point of interest.

A small formal pool, close to the house, sunk in the center of the terrace floor or located close to the steps leading from the side porch to the garden, is in a position to be seen and enjoyed for many months of the year. Water spouting from a central jet or small fountain figure or flowing from a wall spout or foundation-head above the dipping-well or cistern will give added movement and splash to this popular summer feature. House plants or other potted plants set around it will appreciate the moisture-filled atmosphere close to the spraying water.

In the garden the symmetrically shaped pool may occupy the center of the area and serve as a low, flat architectural feature about which the garden's paths and


DIPPING CISTERN AND WALL FOUNTAIN
LILY POOL AT END OF GARDEN
H. B. Aul.

Courtesy N. Y. *Herald Tribune.*

flower beds are related. Or, it may be located at the far end of the garden in front of a shelter, bench or other taller structure that terminates the view of the garden from the entrance or house. In a hillside development the small pool may be set against the low retaining wall at one end or side of the garden.

Regardless of the location or type, the pool will be a center of interest where garden visitors may pause for a refreshing moment and to admire aquatic plants in bloom, or be amused by fish or frogs.

Moving water in the garden, whether along a rock-strewn brook or over a waterfall in the natural garden, coming from a jet or spouting out of a wall fountain, by means of a small motor-driven pump, may be used over and over again. The pump is connected with the waterfall or fountain by a concealed pipe or hose and is driven economically by a small electric motor. Pump and motor are housed inconspicuously near the water and may be turned on or off from the house or from any other spot desired.

Gardens built on a hillside scarcely ever utilize water to its fullest extent.

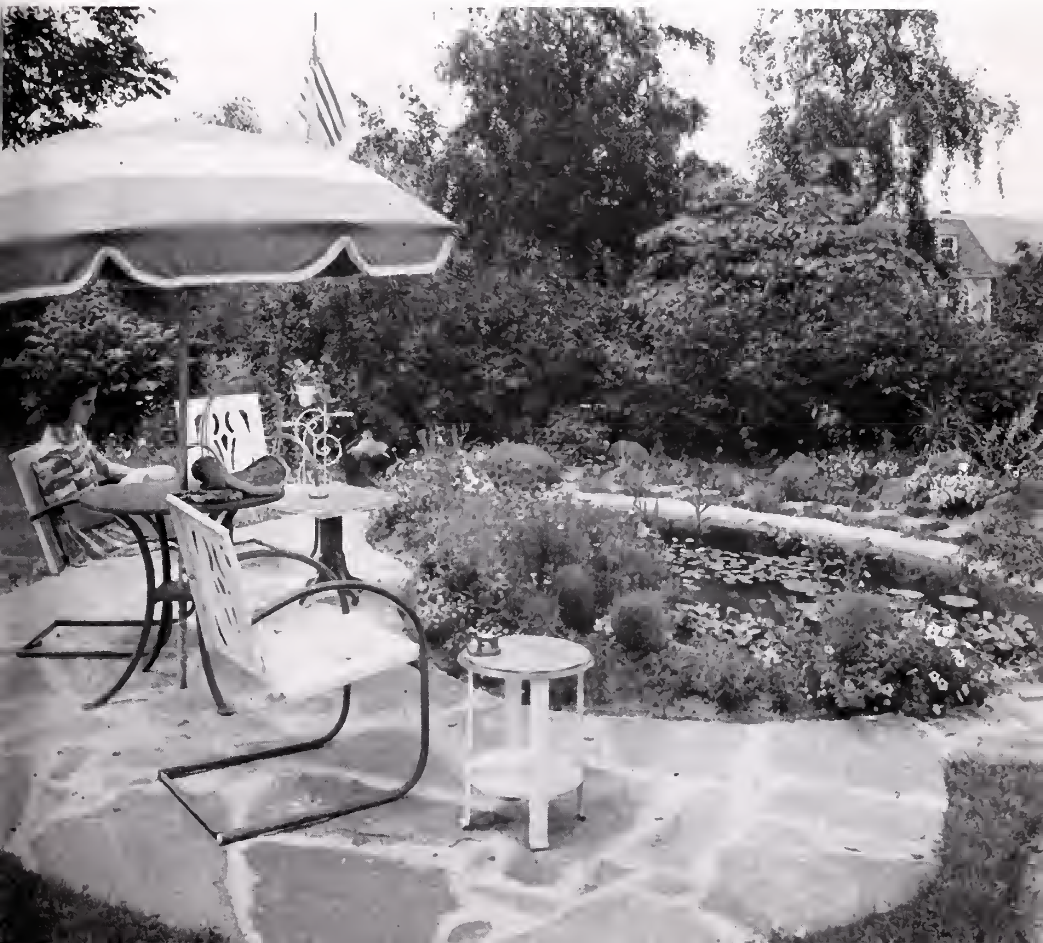
INFORMAL POOL AT EDGE OF GARDEN LAWN

The overflow from a pool high on the house terrace or other part of the development may be led by open channels or concealed pipe to one or a series of other pools at lower levels and finally come to rest in a cistern or well in the vegetable or other garden at the lowest level. Here it may be dipped out for watering purposes or be pumped back to the highest level to start its course over again. Water ramps down the center of garden steps, fountain-fed wall pools and intermediately located reflection basins may be made to produce their share of the display with the same water used over again.

The glory of the quiet pool, other than the reflections it casts, is the opportunity it affords for growing hardy and tropical lilies and other aquatic plants. Pools to be planted should be two feet deep if the lilies are to be grown properly in containers one foot deep. Shallow-water plants grown in containers may be set on concrete blocks, to bring them closer to the water's surface. The planted pool should be located where it will get full sun.

Formal pool, with flagged area.

McFarland photo.



Nymphaea Comanche, a two-toned hardy waterlily.

WATERLILIES

The various kinds and how to grow them

Montague Free

TWO points must be kept in mind by the would-be grower of waterlilies. The pool must be located in full sunshine in order to grow them successfully, and it should be placed so that it will add to, rather than detract from the garden picture.

In north temperate regions there are two groups of waterlilies available for the gardener to play with—the hardy kinds that can survive the winter out-of-doors, and the tender tropical varieties which succumb to frost. In general one would say that the former are best adapted for planting in natural ponds, although they can be, and are, used in man-made pools; while the latter because of their exotic appearance are best displayed in artificial pools.

Hardy varieties

There is considerable variety to be found in vigor, size of bloom and color of the hardy waterlilies. Some, such as the pygmy waterlily, *Nymphaea tetragona (pygmaea)*, can readily be accommodated in a half-barrel, while others, such as Sunrise and Gladstone, quickly form clumps 8 ft. or more across if their roots are provided with plenty of rich soil and the area of water is sufficient. Their flowers vary in size from the 1½ in. to 2 in. of the pygmy lilies to the 6 in. blooms of Gloriosa. The colors range from white and clear yellow through pink and two-tone effects to a rather deep red. Their flowers often float on the surface in contrast with those of the tropical kinds which are held more or less erect above the water, at different heights according to the variety. Good kinds for tub culture and small pools are: Aurora, two-tones, finally becoming red; Gloriosa, red; odorata minor, white; Red Laydeker; White Pygmy; and Yellow Pygmy. For larger pools: Gonnere and Marliac White, white; Formosa, Helen Fowler, Lustrous,* and Rose Arey, pink; Attraction, Conqueror, Gloriosa, and James Brydon, red; Comanche,* Paul Hariot, and Sioux, two-toned kinds, sometimes listed under "sunset shades"; Chromatella, free flowering, and Sunrise,* with very large flowers, yellow.

Tender varieties

The tropical lilies in general are much more vigorous and larger in all their parts than the hardy kinds and are "tender" only in their susceptibility to cold. The flowers of some varieties—Mrs. Edwards Whittaker and Missouri for examples—are frequently a foot or more in diameter. Many varieties are blue and

---

* See plate in color.

Nymphaea Formosa, a hardy kind with pink flowers.

purple, colors which are non-existent in the hardy waterlilies; therefore the color range of the flowers is even greater than it is in the hardy kinds.

The size of plant and flowers is determined in part by the inherited characteristics of the variety and in part by the amount and richness of the soil in which they are planted. It is possible to grow them satisfactorily in boxes of soil 10 in. deep and 15 in. square in which case the individual plants may be no more than 2 to 3 ft. in diameter. On the other hand, if grown as they are in the Brooklyn Botanic Garden, in soil containers which are 4 ft. × 4 ft. × 18 in. they may, if not restrained, develop into plants 12 ft. or more in diameter. Under favorable conditions the rate of growth of these plants is phenomenal. One of the strong-growing tropical varieties, Sturtevant, set out in the Brooklyn Botanic Garden pool as a plant from a 5-in. pot with 3 leaves each about 6 in. in diameter, had in 6 weeks time attained a spread of 16 ft. with individual leaves 2 ft. across!

There are day-bloomers and night-bloomers among the tropical waterlilies. While there are variations in the time of opening and closing it may be said that, in general, the former open their flowers early in the morning and close during late afternoon; and the latter open in the evening and close about mid-morning. So the best time to view a pool containing both night- and day-blooming lilies is about 10 A.M. when both types are likely to have their flowers open. However, in cloudy weather and late in the season the night-bloomers sometimes remain open all day.

Excellent day-blooming varieties include: Blue Beauty, deep blue; Mrs. Edwards Whittaker, lavender-blue flowers, 1 ft. in diameter when well-grown, and Marmorata, the same as the preceding except for its leaves which are striped or mottled with chestnut brown; Pink Pearl,* General Pershing, and Mrs. C.

W. Ward, whose flowers are held higher above water than is usual, are pink; Mrs. G. H. Pring, white, and St. Louis, yellow, although of comparatively recent introduction, are now indispensable.

Among the night-blooming varieties of merit are: Missouri,* white; Emily Grant Hutchings,* Mrs. George C. Hitchcock, pink; H. C. Haarstick, brilliant red.

How to grow them in artificial pools

The soil preferred is a rather heavy loam. If possible it should be prepared a year in advance by making up a compost of ⅔ soil and ⅓ cow manure turned and mixed once or twice during the year. If this is impracticable use fertile soil from the vegetable or flower garden.

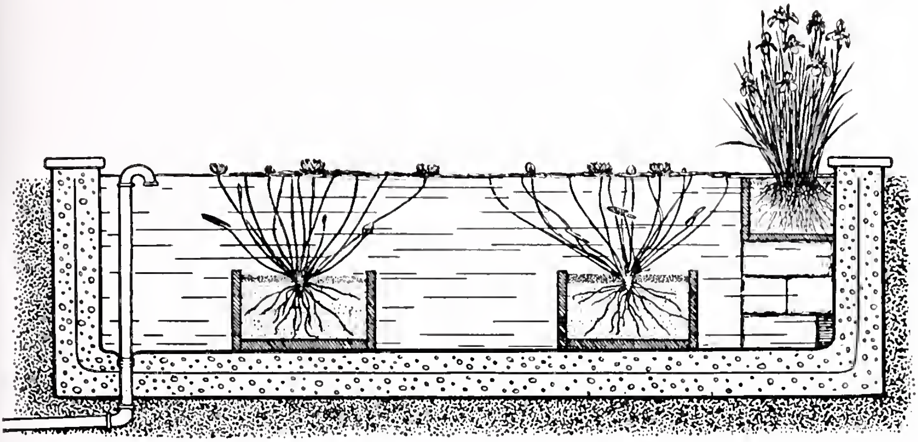
There are two methods of growing lilies in artificial pools. One is to cover the bottom of the pool with 6 to 8 in. of rich earth and plant the lilies directly in this. The other is to use soil containers of wood or concrete. The first method has its disadvantages if it is necessary to get into the pool to care for the lilies, because mud is stirred up and the water loses that clarity which is one of its attractions. However, the lilies grow vigorously under these conditions. If planting is done in containers these should be correlated to the size of the pool. As previously indicated, the size of the container has a definite bearing on the size attained by the plants grown in them. For a small pool, say, 6 ft. × 8 ft., wooden boxes 15 in. square and 10 in. deep would be suitable. Such a pool could contain as many as 6 boxes of hardy lilies if the objective is to grow as many kinds as possible; but if a more artistic effect is desired it would be better to restrict the number to 2 or 3 because it is desirable to have a fair expanse of water visible. In larger pools the boxes may be up to 4 ft. square and a foot deep. The wood preferably should be cypress, although almost any kind of wood lasts well when continuously under water. In the smaller sizes lumber an inch thick is sufficient, but for those that are 2 to 4 ft. across a thickness of 1½ or 2 in. is preferable.

Sometimes the pool is constructed with concrete soil containers as an integral part of the pool below its floor level. If this practice is adopted of course one does not have to worry about their breakage or decay. But, on the other hand, a difficulty presents itself if it should seem desirable to rearrange the spacing of the lilies.

Professional gardeners commonly put an inch or two of broken flower pots in the bottom of the containers. This serves no purpose whatever except that of occupying space that should be used for soil, and arises from doing something without knowing *why*. The custom doubtless originated from the routine practice of putting drainage material in the pots in which land plants are grown—necessary to help to prevent waterlogging of the soil which drives out the air essential for their roots. Waterlilies, obviously, are adapted to growing in waterlogged soil.

Nymphaea General Pershing, a day-blooming tropical waterlily.

Nymphaea Lotus dentata, Sierra Leone waterlily, a tropical night-bloomer.



Section through lily pool. Inside length 8 ft., depth 2 ft. Note provision for overflow and drainage with slight slope to drain.

Planting

Hardy waterlilies may be planted any time while the plants are growing, but the best time is when growth is beginning, early in the spring. If the pool can be drained, enough water should be drawn off to expose the soil. The rhizomes or tubers should be planted with the growing point visible above the surface. Level off the soil and cover the whole surface with an inch of clean sand. This will help to prevent the water from becoming roiled through the activities of the fish which, presumably, will be kept to take care of mosquito larvae. After planting is finished the pool should immediately be filled with water.

Planting tropical varieties

There is nothing gained by setting these out before the weather has become settled and warm, which is usually about the middle of June in the vicinity of New York. The pool should be filled with water fŏr a week or two ahead of planting time so that it warms up before the plants are set out. No water should be drawn off to aid planting unless it can be replaced with water of the same temperature. The containers should have been prepared for planting beforehand by filling with soil and by covering the surface with sand as described in the previous paragraph. When setting the plant take out no more soil than is necessary to allow for the insertion of the ball of earth as it comes from the pot in which the young plants are grown. Do not set the plants any deeper than they were in the pots. Be careful to avoid exposing the leaves to sun and air any longer than is necessary, because they quickly dry unless floating on water.

Planting in natural pools

If a natural pond with rich mud in the bottom is available, the planting and cultivation of waterlilies is a simple matter indeed. In the case of the hardy varieties all that one has to do is to obtain a dormant rhizome or tuber, tie it to a brick and drop it in the water at the place you wish a clump to grow. One precaution to be observed is to be sure that the water is not more than 3 ft. deep, but deep enough so that in winter the roots will not freeze. If tropical lilies, which are usually obtained from dealers as individual plants growing in 4 or 5 in. pots, are to be planted in such a pond it is necessary to put on a bathing suit or rubber boots, wade into the pond and scoop out a hole to receive the ball of earth. The depth of water over the tropical lilies, preferably, should be about a foot. If it is thought that the mud in the pond lacks richness, or is of insufficient depth, the lily may be planted in rich soil in a shallow crate (about 8 in. deep) which is then gently introduced into the water. A slatted crate is desirable so that the roots can freely emerge. To prevent the soil from sifting out, the spaces between the slats can be stuffed with sods, or covered with burlap.

Propagation

Hardy lilies are easily propagated by digging up portions of the clump in the spring and resetting them immediately. The increase of tropical lilies is a rather more complicated procedure. Some varieties have viviparous leaves which produce plantlets at the junction of leaf stalk and blade. When these young plants begin to form the leaf may be cut off and the plantlet potted and submerged, covered with an inch or so of water, in a tank in a greenhouse. Another method is to stop the drainage hole in a 12-in. pot, fill it with soil to within 3 in. of the rim, set the young plantlet in this, and pour in enough water to stand 1 in. above the surface of the soil. As the plant grows additional water can be added until the pot is full to the brim. Plants raised this way must be kept over winter in a sunny greenhouse. Thus treated they may produce a few flowers during the winter and will be strong plants suitable for setting out the following June.

Some varieties of tropical waterlilies produce small tubers around the base of the old plant. In fall when the tops have

Nymphaea Dauben, one of the viviparous kinds.

A natural pool.

McFarland photo.

been killed by frost the plants may be dug up and stored for a week or two on the floor of a frost-proof shed or garage. When the soil has dried out somewhat a search should be conducted for the tubers, which are the size of a filbert or small walnut. These should be put in moist sand in a container covered with a pane of glass or something similar to keep rodents away. If a greenhouse is available the tubers may be started in March by planting them in soil in 6 in. pots submerged with 3–4 in. of water over them. Each tuber may produce several plants, and as they develop they may be pulled away from the tuber and potted up separately. Plants growing in rich soil in large containers are shy in their production of tubers, and this is one of the reasons why commercial men grow their propagating stock in 6 in. pots, which, while restricting growth, results in tuber formation.

Another way of propagating water-lilies is by means of seeds, but as most of those grown are of hybrid origin there is no assurance that the progeny will be exactly like the parent plant. When the flowers have been pollinated and begin to fade they gradually sink below the surface of the water. In order to avoid loss of seeds the old flower should be enclosed in a cheesecloth bag. When the seeds escape from the pod in about 8 weeks the bag may be collected, the seeds separated from the decayed material of the pod, dried and stored in paper bags until it is time to plant them the following March. It is said that seeds of those belonging in the Castalia division (hardy or half-hardy day-bloomers) must be kept moist and cold until they are sown.

The seeds should be sown during late winter in seed pans filled with ordinary garden soil, covered with ⅛ in. of sand, and then submerged with about 2 in. of water over them in a sunny greenhouse. Most of the tropical varieties will germinate if the temperature is maintained at about 70°. For the hardy kinds a 60° temperature is sufficient. As soon as the seedlings have made 2 or 3 leaves they may be transplanted to separate pots, ultimately to be set out in the pool.

Summer Care of Plants

In the interests of appearance, yellowing leaves should be removed. A convenient way of doing this is to lash a very sharp knife to a bamboo rod and cut the leaf stalk as near as possible to the crown of the plant. The severed leaf can then be flicked out onto the bank.

Algae, lowly plants which grow in the water and ofttimes mar its appearance, are sometimes bothersome. The use of scavengers—snails and clams obtainable from dealers in water plants—will help to keep the pool clear. Another method of combatting algae is by the use of copper sulfate. Used at the rate of 1 ounce of copper sulfate to 4,000 cu. ft. (a little over 2 lbs. per million gallons), many species of algae will be killed if applied before the algae have made much headway. (It is said that the killing dosage of copper sulphate for trout is 1.2 lbs. per million gallons; for goldfish 4.2 lbs.) A convenient way of introducing the copper sulfate into the water is to put

A back-yard water garden.

McFarland pho

the crystals or powder in a cloth bag, tie it on the end of a stick and swish it through the water. According to *Science News Letter*, August 5, 1944, "Algae or green slime can be controlled in a garden pool by potassium permanganate; a teaspoonful of a saturated solution of this chemical for each gallon * of water in the pool will not injure lilies or fish." This method, however, has not been used here.

The leaves of waterlilies are sensitive to insecticides applied in sufficient strength to kill the insects which sometimes attack them; so, when aphids make their appearance as they often do, the best method of fighting them is to knock them off the plants with a spray of water from the hose so that they fall into the water where they are eaten by the fish.

The larvae of Hydrocampa which cut off pieces of leaf to fashion into a shelter while feeding on the leaves, may be controlled by hand-picking or by scooping up the floating individuals with a net. When much trouble is experienced from this insect it has been recommended to place a pan of water with a film of kerosene in it in the vicinity of the pool. A light placed over the pan attracts the adults which flutter around and fall in the kerosene-covered water.

Winter Care of Plants and Pools

Hardy waterlilies may be left outdoors all winter if there is sufficient depth of water over them to prevent their roots from freezing. In artificial pools float a few logs in the water to take up the expansion of the water when it changes to ice and thus help prevent injury to the walls. If the water is too shallow to prevent freezing of the roots, the pool, if small enough, may be bridged with boards covered with straw or leaves to prevent the water from freezing deeply. When this is not practicable drain off the water (siphon it out with a hose if a drain is not provided) and cover the lilies with 6 in. of leaves, which must be added to as the weather becomes colder.

When an artificial pool is devoted entirely to tropical lilies it should be drained when the flowers and leaves have been killed by frost. As may be surmised from the remarks under "Propagation" it is not too easy to carry tropical waterlilies over the winter without proper facilities. If your plants produce tubers they may be cared for as previously indicated; and the viviparous kinds are not much of a problem if a sunny, warm greenhouse is available; otherwise it is better to rely on dealers and purchase new plants each year.

---

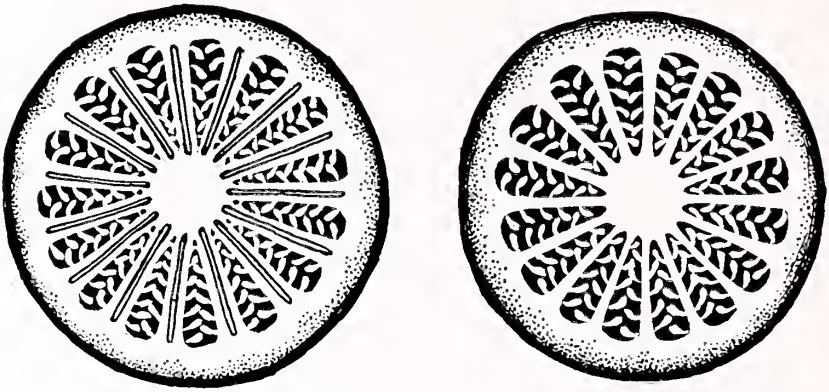
* Seven and one-half gallons = one cubic foot.

ails, Japanese iris and lizard's tail in pool of the garden of "Nyssa" at the New York World's Fair.

WATERLILY CLASSIFICATION

Waterlilies of the genus *Nymphaea* are divided into two main sections:

1. Walls of the seed cavities free at the sides—(*Apocarpiae*)
2. Walls of the seed cavities fused—(*Syncarpiae*)



Sections of seed pods

These sections are further divided as indicated below.

Anecypha—day-blooming
Australia, New Guinea
Not hardy in our area
Brachyceras—day-blooming
Mexico, Texas, Africa
Not hardy in our area
Castalia—day-blooming
North Temperate zone
Mostly hardy in our area

Lotos—night-blooming
Southern Europe, Africa, India
Not hardy in our area
Hydrocallis—night-blooming
Tropical America
Not hardy in our area

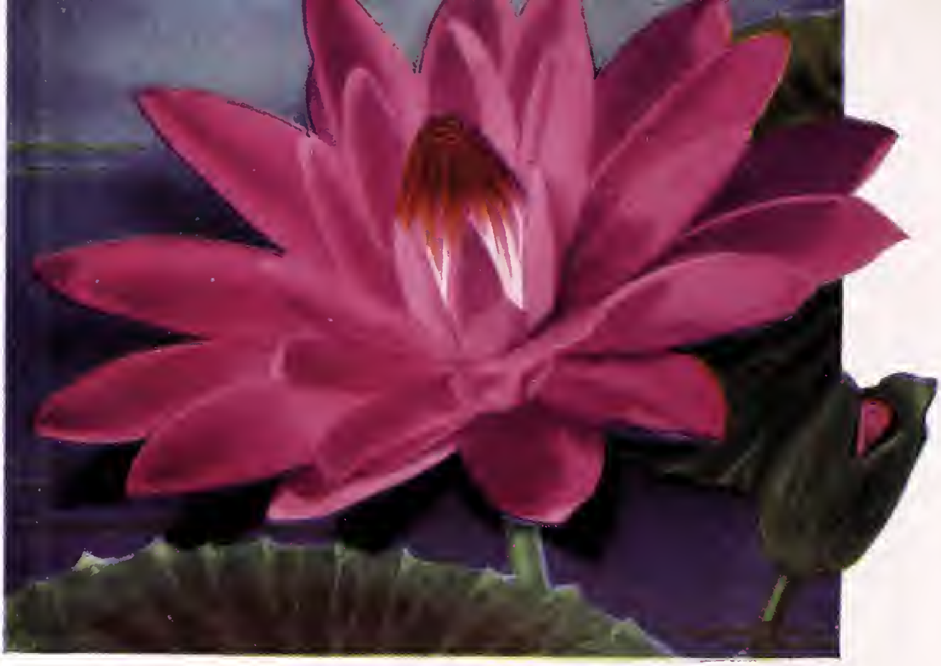
The most important groups for garden purposes are:

1. Brachyceras, including *Nymphaea Burttii, N. caerulea, N. capensis, N. flavovirens; N. micrantha* (viviparous). Various combinations of these have given us many well-known varieties, such as: Dauben (viviparous), General Pershing, Mrs. Edwards Whittaker, Mrs. George H. Pring, Mrs. Woodrow Wilson, Pink Pearl and St. Louis.
2. Lotos, including: *Nymphaea Lotus, N. rubra.* By hybridization of species and varieties of these, garden forms have been produced such as: Emily Grant Hutchings, Missouri, and Mrs. George C. Hitchcock.
3. Castalia, including: *Nymphaea alba, N. mexicana, N. odorata, N. tetragona, N. tuberosa.* Comanche, Conqueror, Lustrous, the Marliac hybrids, Sunrise, and many others have originated from various crossings of these.

* * *

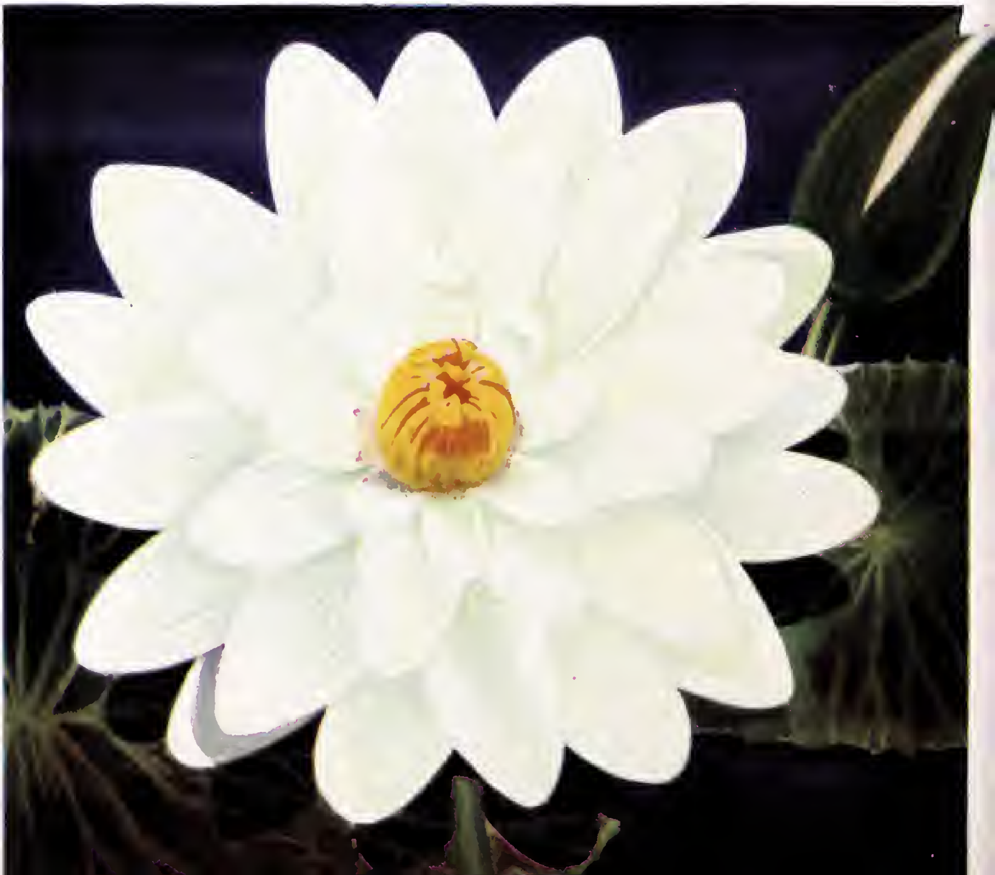
Through the courtesy of William Tricker, Inc., of Saddle River, New Jersey, and Independence, Ohio, we are enabled to present six waterlilies in color. Three of them are tropical varieties: **Emily Grant Hutchings** and **Missouri** are night-blooming and belong in the *Lotos* group; **Pink Pearl,** also tropical, but day-blooming, belongs in the *Brachyceras* group. The others, **Sunrise Lustrous** and **Comanche,** all day-blooming, are hardy kinds from the *Castalia* group. For a fuller explanation of the various groups of the genus *Nymphaea*, and something of the ancestry of the garden varieties, see p. 96.

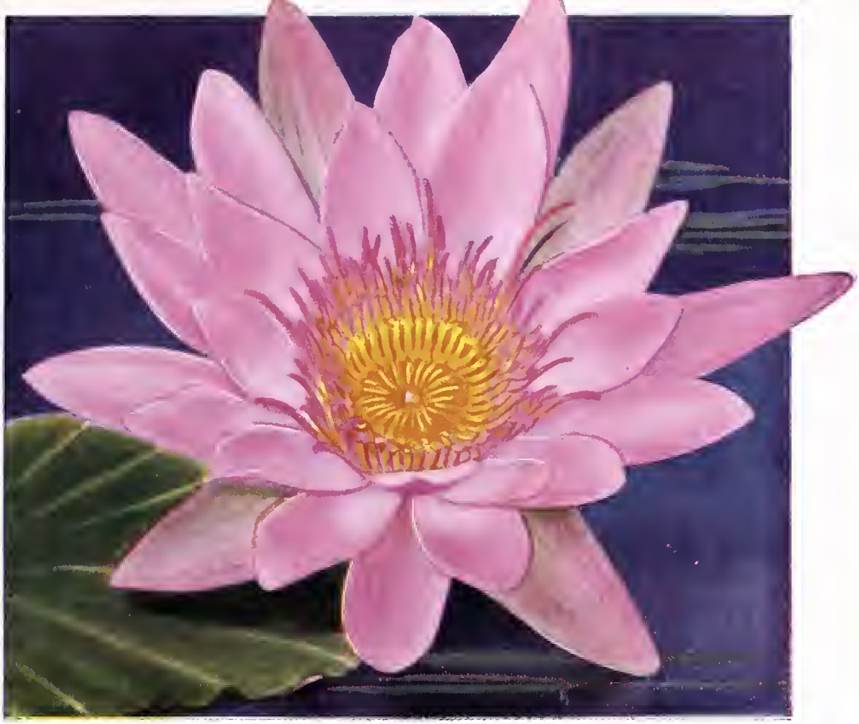
* * *



Above: Emily Grant Hutchings

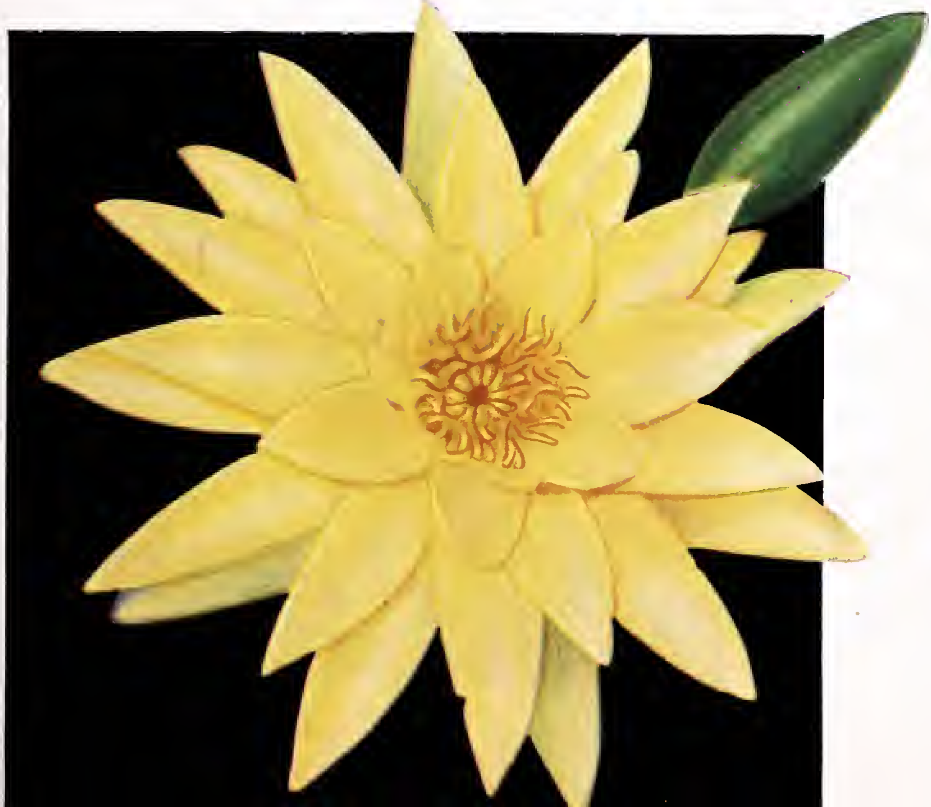
Below: Missouri

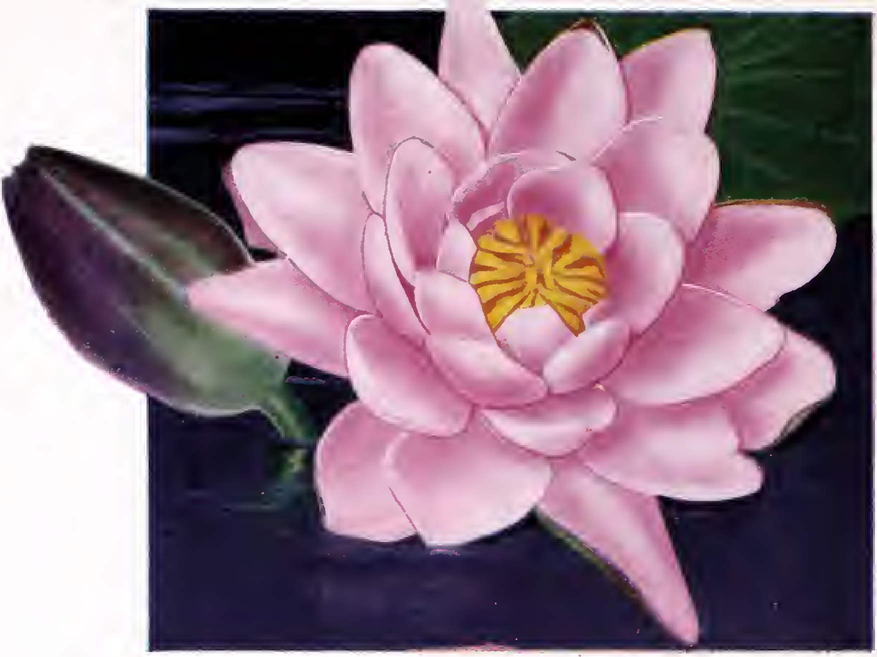




Above: Pink Pearl

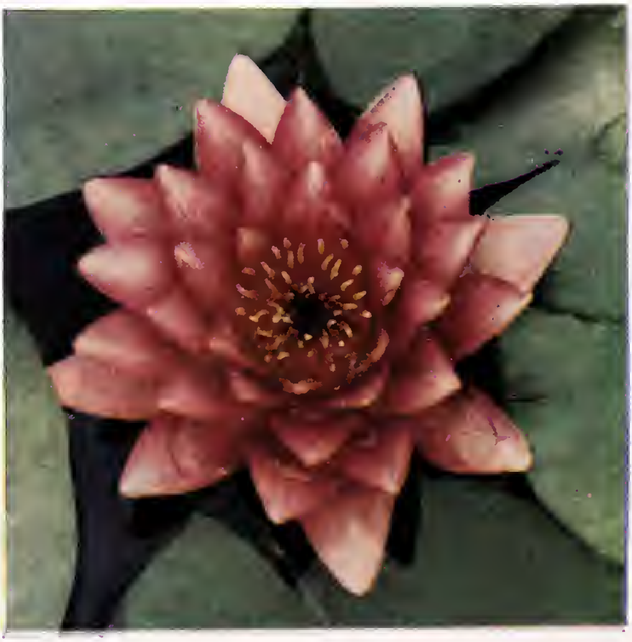
Below: Sunrise





Above: Lustrous

Below: Comanche



OTHER AQUATICS AND WET SOIL PLANTS

To provide variety in the water-garden

Hester M. Rusk

WHILE waterlilies provide the main reason for having a pool, the water garden will be more interesting if it has other kinds of plants as well, some with smaller flowers, some with more delicate leaves, and especially some taller ones. An excellent subject to relieve the flatness of the lily pool is the Japanese iris, *I. Kaempferi.* The plants may be dug from the open ground when the flower buds begin to form, and potted in butter tubs or large flower pots which are sunk to the rim in the water. The picture on p. 83 shows them thus used in the water basin of the Jenkins fountain in the Garden. The East Indian lotus, *Nelumbo nucifera,* often raises its huge round leaves and large fragrant pink flowers several feet above the water. Its long banana-like tubers are planted horizontally 2 inches deep in the soil under at least 6 inches of water, after the water has become warm. The plant is best suited to large pools; but if planted in a natural pond it may spread too profusely and necessitate drastic measures to keep it in check. Here in the Garden we have to mow off the superfluous growth with a scythe operated from a boat. The umbrella-plant, *Cyperus alternifolius,* earns its name by having umbrella-like clusters of narrow shining leaves raised on "handles" 2 or 3 feet tall. Its relative, the papyrus, *Cyperus Papyrus,* grows much taller, and has many thread-like streamers drooping from the tips of the stems. Both of these plants grow well in shallow water, but will not stand freezing.

For Shallow Water

Plants which grow best in water only a few inches deep can easily be accommodated if the pool is constructed with a shallow shelf-like extension at the margin, or if boxes of soil are raised nearly to the surface of the water. Forget-me-not, *Myosotis scorpioides,* does well in such a situation, and gives a dainty air of naturalness which is particularly desirable for an informal pool. A very different effect is produced by the water-hyacinth, *Eichhornia crassipes,* with its stiff spikes of big lavender flowers, and its broad shiny leaves, floating by means of spongy air-holding swellings at the bases of their stalks. It is more vigorous when given an opportunity to anchor its roots in rich mud, but it will also grow floating free in the water.

For low-growing yellow flowers in shallow water, any one of 3 plants may

East Indian Lotus, *Nelumbo nucifera.*

Water-hyacinth, *Eichornia crassipes.*

be used: the long trailing primrose creeper, *Jussiaea repens,* partly submerged, with small leaves; or, for larger, floating leaves, either the water poppy, *Hydrocleis nymphoides,* with blackish centers in its flowers; or the floating heart, *Nymphoides peltatum,* with fringed petals, a vigorous weedy plant whose rapid-spreading habits make its use undesirable in any location where it cannot easily be curbed. The water snowflake, *Nymphoides indicum,* has white flowers curiously fringed like those of its relative the floating heart; if its leaves are broken off, they produce roots which grow down through the water into the soil. The parrot feather, *Myriophyllum proserpinacoides,* has tiny inconspicuous flowers, but its delicate feathery leaves on trailing stems are ornamental enough in themselves; it is particularly subject to attack by the white fly. None of these plants can be depended on to stand freezing except forget-me-not and floating heart.

Floating and Submerged

A few floating plants are appropriate in a pool if they are confined in anchored wooden hoops. Water fern, *Ceratopteris pteridoides,* and water-lettuce, *Pistia stratiotes,* can be grown successfully this way; also water-hyacinth, mentioned above for rooting in shallow water. But such small plants as mosquito fern, *Azolla caroliniana,* duckweed, *Lemna minor,* and salvinia, *S. brasiliensis,* look too untidy floating free and blown about by the wind; they show to much better advantage growing in small tubs by themselves.

Submerged aquatics, such as anacharis, *Elodea canadensis,* fanwort, *Cabomba caroliniana,* and tape-grass or eel-grass, *Vallisneria spiralis,* will grow vigorously, rooted in shallow water; but they are largely wasted in an outdoor pool viewed only from above; and their alleged value as water purifiers is very doubtful.

For the Margin of the Pool

Just outside of the pool it is desirable to have plants which naturally do well in moist situations. These will relieve the abruptness of the pool's margin and harmonize with the water plants as well as with the rest of the garden. Some of our handsome native plants are particularly suitable for the border of an informal pool. A really wet soil is needed for some of them, such as the marsh marigold, *Caltha palustris,* brightening the ground in early spring with its rich yellow flowers and shining roundish leaves; the double-flowered variety is even showier. Later in the season comes the arrowhead, *Sagittaria,* with clusters of clear white flowers on stalks a foot or 2 tall, and interesting erect arrow-shaped leaves. The closely related water-plantain, *Alisma Plantago-aquatica,* has clusters of tiny white flowers, almost like baby's breath, and will grow either in sun or in shade. The most striking of this group is the cardinal flower, *Lobelia cardinalis,* coming out in late summer and fall with tall shafts of bright red flowers of breath-taking beauty. Sweet-flag, *Acorus Calamus,* and cat-tails, *Typha latifolia* and—better—*T. angustifolia,* cannot qualify as showy-flowered plants, but their tall graceful leaves often give just the effect that is needed. Cat-tails need watching, or they will take the whole place. Our native blue flag, *Iris versicolor,* will harmonize with *I. Kaempferi,* as will also the European yellow flag, *I. pseudacorus;* but the latter must have its pods cut off before the seeds are ripe, or it will soon become too plentiful. Varieties of the Japanese iris itself may be planted around the pool as well as in it; some good ones are Betty F. Holmes, double, white; Elbrus, double, light blue with white veins; Light in the Opal, double, orchid pink; Violet Beauty, single, dark blue purple. The Siberian iris, *I. sibirica,* gives a little variation with its graceful narrow leaves. Some good varieties are Snowcrest, pure white; Gatineau, pale blue-purple; Morning Magic, pale red-purple; Caesar's Brother, dark purple, almost black. Clusters of pink flowers and very narrow leaves are borne on the flowering-rush, *Butomus umbellatus,* which grows 2 or 3 feet tall —perhaps best in calcareous soils.

Native Plants for Moist Soil

Among the many good water-side plants which do not have to be rooted in mud, wild plants, again, are prominent. Ferns are especially satisfying, for they do not flare into bloom and then fade into insignificance, but maintain their graceful beauty throughout the growing season. Some of them grow just as well or even better in the sun, if they have plenty of water at their roots. The royal fern, *Osmunda regalis,* is a particularly fine one which grows best in the sun and in a very rich soil. The cinnamon fern, *Osmunda cinnamomea,* will grow in either sun or shade, and is a little more interesting in the spring when its "cinnamon sticks" (or spore-bearing leaves) are out. Both of these ferns form large clumps 3 to 4 feet tall or more. A lower one (1 to 2½ feet) that does well in sun or shade is the hay-scented fern, *Dennstaedtia punctilobula,* very lacy, and quickly spreading over large areas. Some that should have partial shade as well as a rich moist soil are the maidenhair fern, *Adiantum pedatum,* a specially delicate and beautiful one, growing up to 2 feet tall; the lady fern, *Athyrium Filix-femina,* growing in clumps 2 or 3 feet tall, with leaves not quite so lacy as those of the hay-scented fern; and the ostrich fern, *Pteretis nodulosa,* on the order of the cinnamon fern, but perhaps more graceful. All ferns need a friable soil with plenty of humus, and are transplanted most safely when they are dormant.

Of the wild flowering plants that thrive in moist soil, some striking tall ones are the purple New England aster, *A. novae-angliae,* and some of its varieties, such as Barr's Pink, and Mrs. J. F. Rayner, rosy-red; the rosemallow, *Hibiscus Moscheutos,* and some of its hybrids with extra-large flowers, white to crimson in color; and loosestrife, *Lythrum Salicaria,* an Eurasian plant widely naturalized in North American marshes, with long spikes of reddish-purple flowers. Wild specimens of the last, carefully chosen for size and color of flowers, may be dug up and propagated by division of the rootstock. As a ground-cover one may use creeping Charlie, *Lysimachia Nummularia,* which has attractive round leaves, and bears yellow flowers about an inch wide all summer.

And Exotics

Very different in appearance are some strictly cultivated plants suitable for moist situations by the pool, including two spiraea-like kinds, both often sold under the name *Spiraea*. One of these is astilbe, *A. japonica* varieties, with white or pink flowers. Good ones are Queen Alexandra, pink, and Gloria, deep pink, both about 2 feet tall. The other is meadowsweet, *Filipendula*. *F. hexapetala* has loose flat-topped clusters of white flowers, single or double. A form of *F. rubra* sold by nurserymen as *F. venusta* is taller, and has long branching clusters of deep pink flowers.

A group of ornamental grasses known as eulalia, *Miscanthus sinensis*, has numerous horticultural varieties about 3 to 5 feet tall, including maiden grass, with graceful tufts; and some variegated ones, such as the yellow-barred zebra grass, and a white-striped one.

All the water-side plants mentioned so far are hardy. Some handsome tender ones, whose fleshy rhizomes or tubers must be stored in a frost-proof cellar in the winter, include the garland-flower, *Hedychium coronarium*, with canna-like leaves and spikes of fragrant white flowers 3 or 4 inches wide; and several taro-like plants, species of *Colocasia* (popularly called *Caladium*), grown for their interesting foliage, which gives the place a tropical air.

Stream and bank planting.

McFarland phot

THE STORY OF WATERLILIES

Something of their history and development

Elizabeth Clarke

WATERLILIES have been known since remote antiquity. Strictly speaking the term waterlily should be applied only to the genus *Nymphaea;* however, it is commonly used for many others, including the royal waterlily, *Victoria regia,* and the East Indian lotus, which is *Nelumbo nucifera.* Even more confusing is the fact that the true Egyptian lotus is a waterlily (*Nymphaea Lotus*). Types of Nymphaea are scattered throughout the world, and the presence of fossil, tropical species in Europe indicates that the European climate was mild prior to the Ice Age.

In the Nile delta there are two species: *Nymphaea Lotus,* a white night-blooming waterlily whose flowers close by mid-morning, and *Nymphaea caerulea* with blue flowers that open in the morning and close at night. The early Egyptians regarded these two water plants as symbols of life and immortality as well as resurrection. They believed that the so-called lotus was the mystic habitation of spirits of the blest. Their fondness for it is shown by the drawings on the walls, furniture and anything they wished to ornament. The starchy tubers were a source of food and medicine. Although the blue lotus (*Nymphaea caerulea*) was probably more common than the white one which opened in the evening, the white species was cultivated in gardens, and because of its fragrance it was more frequently carried by the ladies at their entertainments.

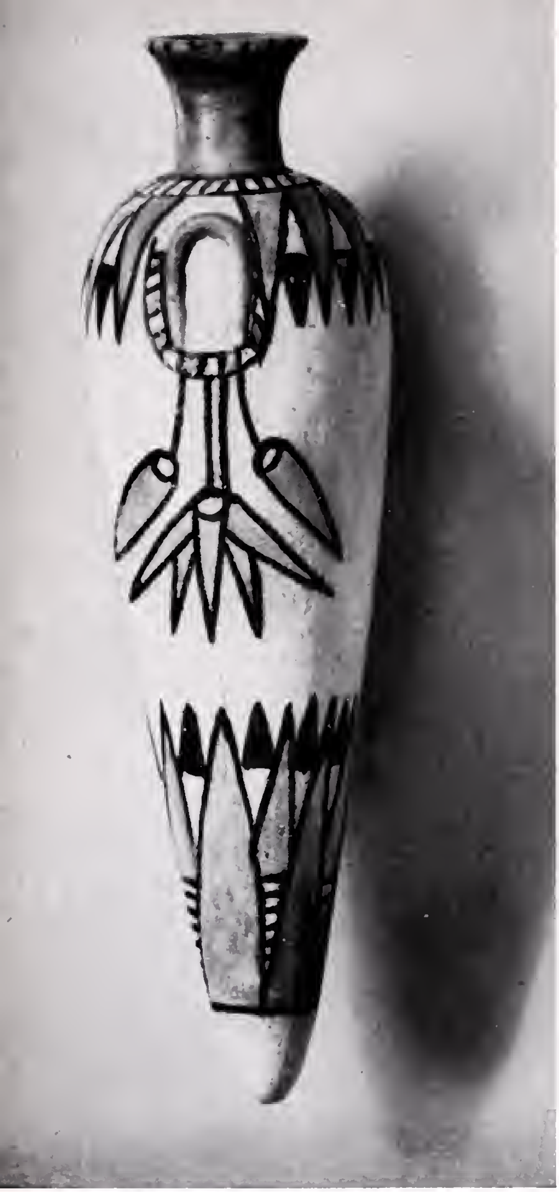
The sacred Egyptian lotus has always had a prominent place in ancient civilization and the flower has been loved and worshipped since the Fourth Dynasty, about 4,000 years before Christ. It was used as an offering to the dead or placed on altars before the gods. The love of *Nymphaea Lotus* continued, for petals of it were found in the sarcophagus of Rameses II (1580 B.C.). As ancient Egyptian religion died out the waterlily ceased to be cultivated extensively in their gardens.

In art and literature waterlilies have played an important part; perhaps they are in the writer's mind in I Kings: 26, for in reference to the pillars of King Solomon's temple, we read: "and it was an hand breadth thick, and the brim thereof was wrought like the brim of a cup with flowers of lilies."

While the cultivation of waterlilies is very old, their culture in Europe is comparatively recent. It was attempted in England during the 18th Century. Philip Miller, in his Gardener's Dictionary (1731), said: "In some gardens I have seen plants cultivated in large troughs of water where they flourish very well and annually produce great quantities of flowers but as the expense is pretty great there are but few people who care to be at the charge."

The tropical *Nymphaea devoniensis* perhaps the first variety of garden origin, was named for the Duke of Devonshire, in 1851. His gardener, Paxton, grew tropical waterlilies in specially built houses and this new rosy flowered one appeared. At first it was believed to be a hybrid, but since then this has been questioned and it is now considered that it might have been a self-pollinated seedling of *Nymphaea rubra.* However, it served as an incentive for growing tropical aquatics.

The first extensive attempt to hybridize any waterlilies was made by a French enthusiast, M. Latour Marliac. He used



Two handled amphora. Egypt. XXVI Dynasty (663–525 B. C.) Faience. Decorated in blue and black design of lotus petals around shoulder and bottom; a lotus flower and two buds hang from each handle. Courtesy of The Metropolitan Museum of Art. [*Nymphaea caerulea,* Egyptian lotus motif. Ed.]

the American *Nymphaea odorata* as a parent for many of his crosses. Near the end of the 19th Century he introduced a yellow and pink hardy waterlily. These new creations gave the greatest impetus for water gardening, and today some of the many Marliac type hybrids are still favored in hardy waterlily gardens.

In America William Tricker became an authority on waterlilies as well as other aquatic plants. One of his early water gardens is shown on p. 81. James Gurney, former head gardener at the Missouri Botanic Garden also introduced some new tropical lilies. Interest continued, and G. H. Pring of the Missouri Botanic Garden started experimenting with them in 1912, endeavoring to increase the range of colors of the tropical day-blooming waterlilies, in which he was eminently successful.

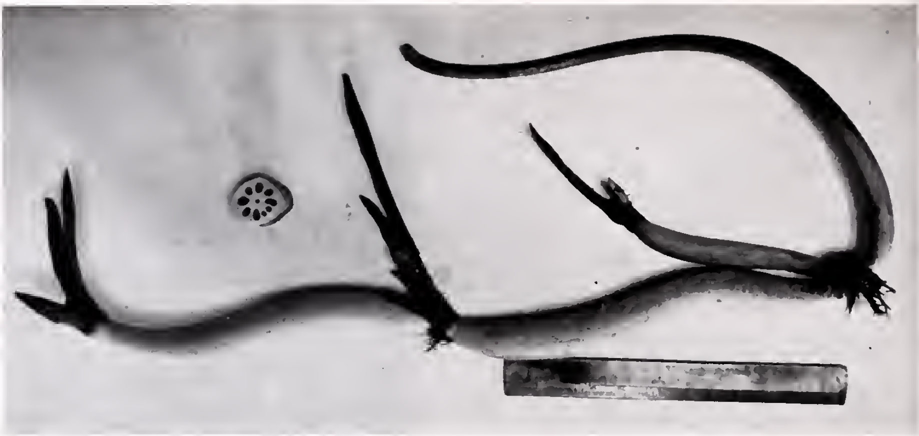
Day-flowering tropical waterlilies had been limited to pink and blue but there was a demand by growers for a white variety, and in 1919 crosses were made to try to obtain this. Using the African species, *Nymphaea ovalifolia* and the hybrid "Mrs. Edwards Whittaker" for parents, plants having the desired characteristics were obtained. After several years more of selection and breeding the white coloration was fixed; a new flower was created. In Kansas City in 1922 at a meeting of the Society of American Florists and Ornamental Horticulturists, Mr. Charles Tricker, the waterlily specialist, stated that the "new hybrid presents the biggest one jump in the development of a new waterlily to date." The flowers of this sensational white tropical day-blooming waterlily, "Mrs. G. H. Pring," are 8 to 10 inches in diameter.

With water gardening at a new high, still another color was desired and the search for a yellow hue, started in 1915, was continued. Previously there had been described only two tropical yellow species, *Nymphaea sulphurea* and *Nymphaea Stuhlmannii.* After more than 10 years of search, in 1929 seed of a yellow Afrian waterlily was obtained. This was liscovered to be a new species with lowers somewhat larger than the other species and was named *Nymphaea Burttii* commemorating the collector, Mr. B. D. Burtt. Countless crosses with other lilies were made in the hope of developing tropical lilies in yellow and other colors. Finally it was accomplished and "St. Louis," the first hybrid yellow tropical waterlily, was offered to the public and immediately achieved sensational success. It received the Henry Shaw Medal at the National Flower Show in St. Louis and is now listed in commercial catalogues. G. H. Pring of the Missour Botanic Garden is responsible for this yellow hybrid and the introduction of others that help complete the range of colors now available.

No discussion on waterlilies seems complete without some reference to the East Indian lotus (*Nelumbo nucifera*) which is not to be confused with the Egyptian lotus, *Nymphaea Lotus,* a true waterlily. The East Indian lotus, native of India, China and Japan, may have formerly grown in Egypt and the Mediterranean countries in prehistoric times but it disappeared from that region and now it is generally understood that the lotus was introduced again to Egypt—perhaps by the Persians. There seems to be no conclusive evidence of the lotus, *Nelumbo,* in early Egyptian art so it is now believed by most authorities that it was not known in Egypt until about 500 B.C., the advent of the Persians.

This lotus is grown in all parts of the world. In art we frequently find Buddhist and Brahman deities seated on the lotus. It is the sacred flower of the Buddhist temples. When the lotus is in full bloom there are also seed pods and seeds ready for the renewal of life, symbolizing the immortality of the soul; the root, growing in the mud, a symbol of the past, the flower in token of the present, and the seed a promise of the future. In Japan it is an emblem of purity—never disfigured by the mud in which it grows.

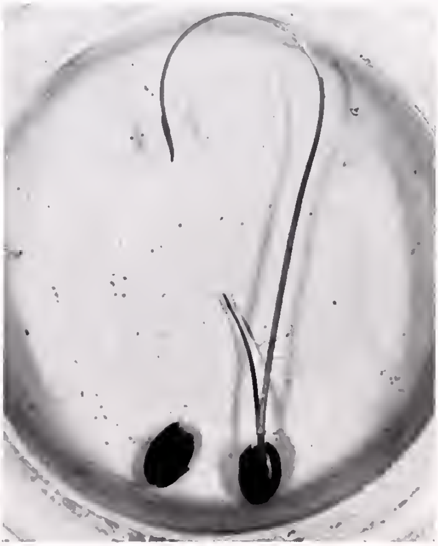
Fan Holder. China. Ch'ing Dynasty. (1644–1912). Embroidered silk. Pale yellow satin; design of lotus blossoms and leaves, in appliqué satin, in brilliant colors. Lotus in fine red silk; pale yellow cord, gold cord beads. Courtesy of The Metropolitan Museum of Art. [*Nelumbo nucifera,* East Indian lotus motif. Ed.]



Tubers of *Nelumbo nucifera,* with section showing air canals.

The flower of this remarkable aquatic plant grows on a long stalk rising several feet out of the water, and is a solitary fragrant blossom of pink or white, as large as a child's head. The seed pod has been likened to the rose of a watering can because of its shape and perforations in which the seeds are formed. This flat wide surface on a strong erect stem has been depicted many times. In designing fountains it has been adapted frequently, and thus, perhaps, we see small figures holding the lotus seed-pod from which is sprayed a fine mist.

Nelumbo nucifera. Seed from Manchuria estimated to be more than 100 years old. Germinated in three days after filing and placing in water in warm greenhouse.



China and Japan grow quantities of lotus plants. The seeds and slices of the tuber are served at banquets. Frequently the tubers are pickled, and when dried they furnish a starch or arrowroot called "gaou fun." The dark-colored seeds, having some resemblance to acorns in shape, are eaten like filberts and often served at the table.

Every part of the lotus is used—the dried stalks of the leaves furnish fiber used for wicks of lamps. This seems common throughout the Orient and possibly it is a practice in Egypt, for the East Indian lotus now abounds there.

Although it was grown throughout the East Indies for many years, it was not until 1870 that tubers were sent from Japan to be grown in Astoria, Long Island and on Staten Island.

The seeds of this and the following species retain their viability for a long period of time. The picture shows a germinating seed of *Nelumbo nucifera* from Manchuria reputed to be more than 100 years old.

In the southern rivers the Indians cultivated the American species, *Nelumbo lutea,* for food. This lotus, with pale yellow flowers, was probably carried by them East and North until now it is found in most Eastern States.

THE WATERLILY WAY OF LIFE

How a waterlily lives, grows, and reproduces

Arthur Harmount Graves

We do not have to be told that the waterlily way of life is considerably at variance with that of the ordinary land plant, although its household economy (by which is meant the ways in which it gets its food materials and grows and reproduces) does not differ from that of the land plant in the essential details.

But the waterlily (*Nymphaea* or *Castalia*) has become adjusted to an environment quite different from that of the land plant, living in water varying in depth from a few inches to ten feet or more.

The stem is not erect at all, but lies imbedded in the mud at the bottom of the pond, thickened, growing more or less horizontally after the manner of all rootstocks. We are familiar for example, with the rootstocks of grass. What is a piece of turf but a complex of interweaving horizontal rootstocks plus their roots, sending up the "leaves" or grass blades at intervals? As the waterlily rootstock grows, bearing its leaves, roots, and flowers in succession, its older parts die and the newer parts or apical portion may branch (Fig. 1). And when such branches become isolated by the progressive death of the older parts, they thus become new plants. This is one way in which waterlilies may multiply vegetatively, i.e. without going through the process of bearing seed.

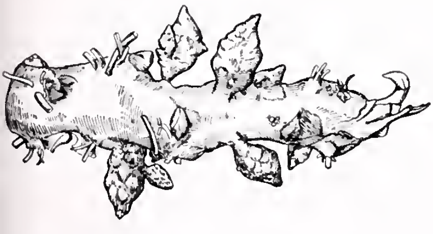


FIG. 1. Showing tuberous shoots from a rootstock of *Nymphaea tuberosa*.

The leaves are wonderfully adapted to meet the exigencies of the situation. The floating leaves (Fig. 3) are the principal kind formed by the plant, although a threadlike submerged form is found with the young seedling, and sometimes an aerial form of leaf develops during the plant's life. The length of the petioles reminds us of the old Abraham Lincoln story. Someone asked him, "Mr. Lincoln, how long are your legs, anyway?" "Why," he said, "they are just long enough to reach the ground." The leaf petioles, extending upward from the rootstock, are always long enough to reach the surface of the water, whether it is a few inches or many feet deep. As a matter of fact they are usually a little longer than this, which enables the floating blades to spread out to some distance from the center of the plant, thus giving room for younger ones to appear inside the circle. Moreover, the petioles are pliant rather than stiff; they could never hold the leaf blade out horizontally as do the petioles of most leaves of land plants. This is because strengthening thick-walled cells are lacking in their construction. Further, water as an environmental medium is of course much heavier than air, and hence itself acts as a support to the leaf.

Let us see also how the floating leaf blades of the waterlily are adapted to their environment.

First of all, **the petioles** are attached at or near the center of the leaf, thus enabling the blade to move freely in one direction or another in response to currents of wind or water. The enormous leaf of the Victoria waterlily (*Victoria regia*) has the petiole attached at the geometrical center of the blade, but in the case of the ordinary waterlilies it is usually fastened at the apex of a deep cleft, which has the same practical result (Fig. 3).

The floating blade of the waterlily leaf is typical of all floating leaves. It is leathery and thus is able to endure the tearing force to which the motion of the water subjects it and also the battering force of the rain which is much more severe than when it is expended upon an ordinary air leaf that can yield readily in such a medium as the atmosphere.

As to its internal structure, the blade of the floating leaf is similar in its essential details to the blade of an ordinary air leaf, with this difference, that the stomata (breathing pores) are all located in the *upper* surface—obviously quite a necessary adaptation.

Air canals. These are a characteristic feature of the internal structure of rootstocks, roots, leaf petioles, and flower stalks (peduncles). The position of these air canals (sometimes called "lacunae") is so characteristic that they are used as a means of distinguishing different groups of the genus *Nymphaea*. For example, in the peduncle of the *Castalia* group there are four large canals in the center arranged to form a square, with other smaller canals outside on the sides of the square; in the peduncle of the *Lotos* group there are six large canals separated by plates of tissue which resemble the spokes of a wheel, and outside is a ring of smaller canals (Fig. 2).

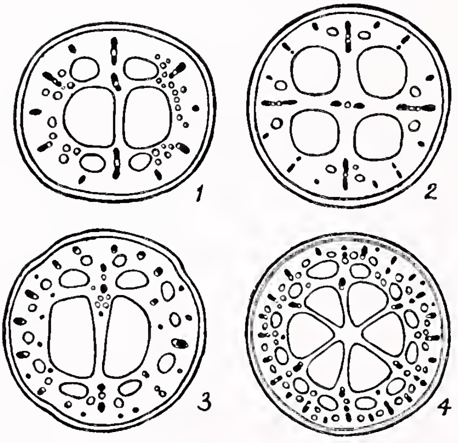


FIG. 2. Showing how size and arrangement of air canals can be used to differentiate members of the genus *Nymphaea*. 1 & 2. Cross sections, respectively, of leaf-stalk and flower-stalk in the *Castalia* group; 3 & 4: cross section of leaf-stalk and flower-stalk in the *Lotos* group. Redrawn from Bailey's *Standard Cyclopedia of Horticulture*. 3 vol. ed. The Macmillan Co., N. Y. P. 2306. 1939.

As to the function of these air canals there has been much conjecture and argument. We do have evidence that they are necessary in the plant's economy, because water plants, grown experimentally on land, diminish the size of their air spaces; and, conversely, land plants grown under water reveal a tendency toward loosening up of the tissues. (Schenck; Vergleichende Anatomie der submersen Gewächse—p. 49, 1886.) They are evidently of use in facilitating gas interchanges which otherwise would be difficult in the submerged parts of these plants. It is probable also that the considerable amount of air, or rather, of gases, enclosed in these intercellular spaces, is of advantage for submerged as well as for floating plants, by its lessening of the specific gravity of the plant.

Vegetative Reproduction: Tubers. Many of the species of *Nymphaea* produce tuber-like shoots (as notably in *N. tuberosa*) which become separate from the plant and serve to reproduce the species, or are formed at the approach of winter and, being hardened off, carry the plant through this unfavorable time. When such tubers are formed during the growing season, they are easily broken off by wading birds, turtles, fish, and even by deer, which eat the "lily pads" with relish (Fig. 1).

Vivipary. Nearly every season a viviparous species of tropical waterlily (*Nymphaea* "Dauben") may be seen in the north pool in the Conservatory Plaza of the Brooklyn Botanic Garden. All

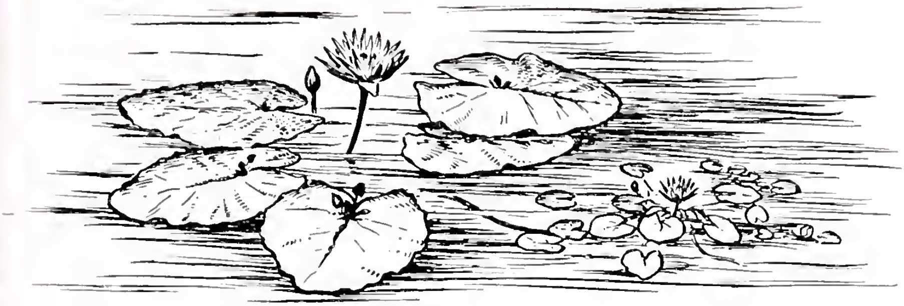


Fig. 3. Plantlets on leaves of *Nymphaea* "Dauben." Old leaf has rotted away from largest plantlet.

summer it forms offsets or tiny plants on the surfaces of its leaves, but only at a particular point, namely, immediately over the place of insertion of the leaf petiole at the leaf blade. Fig. 3 shows this lily surrounded with its numerous viviparous offspring, like a hen with her chickens. As the figure shows, the small fry are blooming, with miniature flowers only about two inches in diameter, but these would attain normal size if the plants, which now float with roots dangling in the water, should be set out in tubs of soil where the roots could receive the mineral food they require. (See article on culture by Montague Free.)

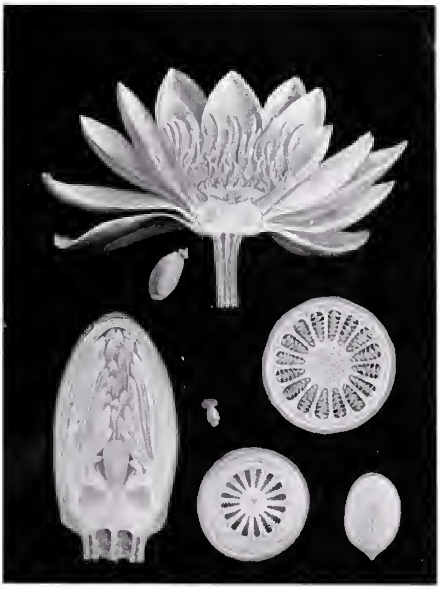
The Place of Waterlilies in Evolution

One is naturally curious to know something about the place of waterlilies in the evolution of flowering plants—in the "scheme of things," as we say.

The flowers, which in respect to variety of colors and large size stand at the top of the list of ornamentals, are not very different in structure from those of the buttercup and the magnolia families, and are thought by many botanists to form a link between the flowering plants and the cycads, seed bearing palm-like plants, which were dominant when the dinosaurs roamed the earth perhaps seventy-five or one hundred millions of years ago.

So, there has been plenty of time for waterlilies to have developed their particular way of life through processes of variation, natural selection, and survival of the fittest. However, Prof. G. W. Berry of Johns Hopkins has presented evidence that species of *Nelumbo,* the beautiful waterlily which flourishes in the Brooklyn Botanic Garden lake, were present on the earth in Cretaceous and Tertiary time. Thus the evolution of *Nelumbo,* at least, was accomplished many millions of years ago.

Section of waterlily bud and flower.



Insect Pests and Diseases of Plants

Many hazards confront the successful grower of plants. Some of the difficulties are due to the unfavorable soil conditions; the use of varieties which are not adapted to the region; diseases due to fungi, bacteria, and viruses; and destruction due to animal pests such as nematodes, and many different kinds of insects. We are fortunate in being able to present a series of articles on recent progress in the control of plant diseases and insect pests.

INSECT PESTS AND THEIR CONTROL

A lucid account of the principles to be followed in fighting insects

Louis Pyenson

State Institute of Agriculture,
Farmingdale, New York

Photographs from kodachrome slides made by the author except when otherwise indicated.

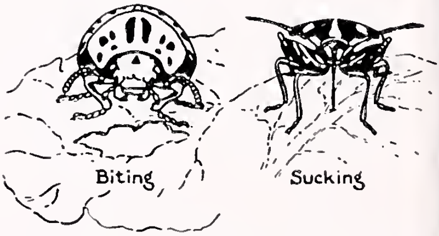
BECAUSE insects appear in so many different sizes and shapes, it is a common misconception that everything that crawls is an insect. To add to the confusion, the growth stages of an insect often differ from each other more greatly than organisms closely related to insects differ from the insect or some of its stages.

In common with many closely related forms, insects are cold blooded. They have a hard or soft outer skin that holds and protects their inner organs; a segmented body; and jointed appendages. But here their likeness stops: their three body regions (head, thorax, and abdomen), three pairs of legs attached to the thorax, and the presence of wings in most adult forms, definitely separate them from other groups and stamp them as insects.

The Main Groups of Insects

Scientifically, insects are divided into groups according to common structural characteristics. The following are some of the groups that contain important plant pests.

The group known as grasshoppers, crickets, and katydids have two pairs of leathery wings and chewing mouth parts. The tiny, elongated insects with rasping-sucking mouth parts belong to the group called thrips. The true bugs (all insects are not bugs) have their top wings hardened except for a membranous tip, and piercing-sucking mouth parts. The aphids and leafhoppers generally have two pairs of wings held roof-like over their backs, and piercing-sucking mouth parts



Mouthparts of "biting" and "sucking" insects.

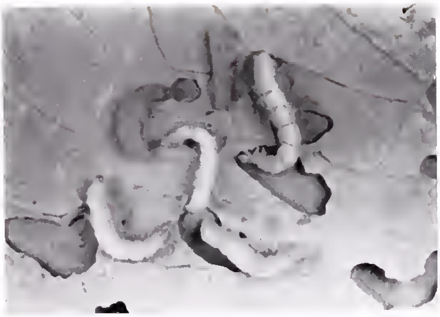
vhich appear to come out of their throats. he scale insects also belong to this roup, but differ in their sedentary habits nd the scale-like covering over their odies.

The group known as beetles and weevils ave hard, non-membranous upper wings nd chewing mouth parts. The moths nd butterflies have two pairs of scale-overed wings; the immature stages hew, but the adults have a long sucking tube. The bees, wasps, ants, and sawflies have two pairs of membranous wings and chewing or chewing-lapping types of mouth parts. The flies have only one pair of membranous wings, suck in the adult stage, but have a modified chewing type of mouth part in the immature stage.

Mexican bean beetle—larvae and pupa. Biting insects making lace-work of a bean leaf by eating between veins.

Insect Growth-Stages in Relation to Control

The recognition of insect stages is an important step in their control, as some stages are very difficult to control with chemicals, while other stages succumb easily. The first four groups of insects mentioned above have a gradual metamorphosis in which the young, called nymphs, grow by undergoing a series of molts or sheddings of the skin, and become more like the adult after each molt. The most distinctive feature of a nymph is its wing buds which do not spread out into functional wings until the insect has reached its adult stage. The insects having this type of metamorphosis are best attacked during their early nymphal stages, since at that time they are much more helpless and susceptible to the action of sprays or dusts.



Cabbage worms. Biting insects. Courtesy The Macmillan Co.

The remaining four groups of insects undergo a complete metamorphosis. In this case, when the insect hatches from the egg, it is more or less worm-like, is known as a larva, and in no way resembles the adult insect. The larva grows by periodically shedding its skin until it reaches its full size. It then molts into an inactive stage known as a pupa. In this stage the organs are completely made over into those of the adult. When the changes are complete, the pupa wriggles out of its skin and in a few hours it is an active adult with fully developed wings. Insecticides are most effective

Striped cucumber beetles. Biting insects. Courtesy The Macmillan Co.

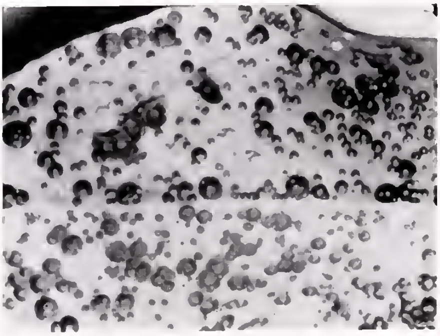
Giant oak aphids—adults and eggs. Sucking insects. *Photo L. Buhle.*

against the young larval stages, are almost wholly ineffective against the pupal stage, and fairly effective against such adults as foliage-eating beetles.

Control Based on Feeding Habits

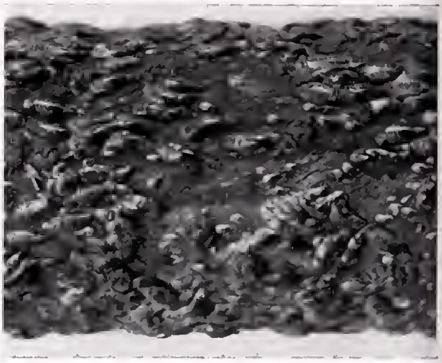
From the standpoint of control, insects are best grouped according to their feeding habits. Insects that chew off and swallow the external parts of plants such as foliage and fruits are generally best controlled by chemicals which are called stomach poisons. Lead arsenate and cryolite are commonly used stomach poisons which are sprayed or dusted on the foliage and have to be swallowed by the insects to be effective. Chemicals that are known as contact poisons (pyrethrum and rotenone for example) kill by coming in contact with the bodies of insects and may also be used effectively against many insects of this type, but they must be applied when the insects are present and not before as a stomach poison may be. The Mexican bean beetle is best controlled with a rotenone dust or spray which has some stomach poison as well as contact effect, but cryolite is also effective when applied against the very young larvae.

Florida red scale on rubber plant. Sucking insect.



Sucking Insects

Insects that suck the juices from within the plants cannot be harmed by a stomach poison on the surface of foliage or fruits and must be hit by a contact poison for effective eradication. Aphids may be controlled effectively by contact insecticides that contain nicotine sulfate, pyrethrum, or rotenone, but leafhoppers are generally more susceptible to pyrethrum.



Oyster-shell scale. Sucking insect. *Photo L. Buhle.*

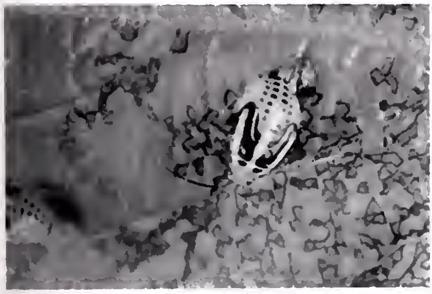
For scale insects it is best to apply a dormant contact spray (before new foliage appears in the spring). Such a spray may consist of a miscible oil or a dinitro compound such as Elgetol.

Borers

Insects that bore into plants or fruits have chewing mouth parts and may often be controlled with a stomach or contact poison before they have a chance to enter the plant tissue. Once they enter, they are relatively safe as far as insecticides are concerned. Timing is very important in these cases and it takes careful observations to determine the correct time for making applications. The eggs of the

European corn borer, laid by the moths on the undersides of the corn leaves in early June, must be watched carefully to determine when they are about to hatch as this determines the time for making the first of four applications at five-day intervals of a spray or dust. When black spots appear in the eggs a 1 per cent rotenone or Black Leaf 155 spray or dust should be applied. This treatment gets the borers before they enter the tissue and are safe.

Borers in trees such as the round-headed apple tree borer and the leopard moth borer that make definite tunnels with exits may be killed with fumigants such as dichloroethyl ether, or nicotine. These chemicals are injected in a liquid state into the tunnels and vaporize as toxic gases, killing the borers.



Nymph of 4-lined plant bug. Sucking insect.

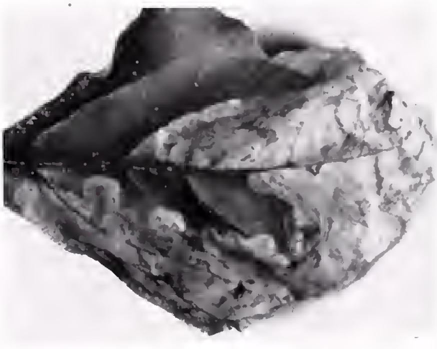
Leaf-miners and Gall-makers

Leaf-mining insects can be reached effectively only during stages spent outside of the leaf. In most cases, this is the adult stage and control has to be timed so as to kill the adult before active egg laying in or on the leaf tissue begins. The beet leaf miner, for example, which caused so much damage to beets, swiss chard, and spinach last summer, can best be controlled by killing or repelling the adult flies with a contact insecticide such as nicotine sulfate or tobacco dust applied at four-day intervals throughout the summer.

Eggs, nymphs, and adult squash bug. Sucking insect.

Sitka spruce gall caused by aphids.

Injury caused by beet leaf miner.

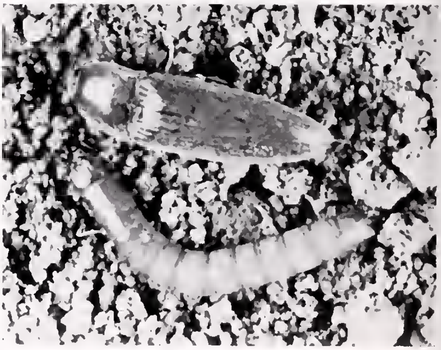


Gall-making insects, such as the spruce gall aphid, are best destroyed before the galls have formed. The spruce galls produced by this insect can be prevented from forming by destroying the overwintering aphids at the base of the buds with a miscible oil or nicotine sulfate spray before new growth begins in the spring.

Underground Pests

Subterranean insects generally attack the roots of plants. They may be either of the chewing, sucking, or boring type. On barren soil they may be controlled by such fumigants as carbon disulfide emulsion and ethylene dichloride emulsion; but where growing plants are involved, care must be taken not to injure the plants. Dichloroethyl ether emulsion has been used successfully at the rate of two tablespoonfuls per gallon of water in destroying grubs and wire worms in the soil about the roots of plants. Some insects may be attacked in their grub stage in the soil and in the adult stage when they feed on foliage or fruits. The Japanese beetle grub may be attacked in the soil with a fumigant such as mentioned above; with a stomach poison, lead arsenate, watered into the soil at the rate of ten lbs. per 1000 square feet of space; or with a bacterial disease, called milky disease, applied to the soil. Against the adult stage, foliage and fruits may be protected with stomach poisons such as lead arsenate, repellents such as hydrated lime or rotenone, contact poisons, such as pyrethrum, and traps, baited with a mixture of geraniol and eugenol.

White grubs.



Wire-worm larva and adult beetle. Courtesy The Macmillan Co.

BOOK NOTICE

Annual Flowers from Seed Packet to Bouquet, by Dorothy H. Jenkins.

"Annual flowers from seed packet to bouquet" is the title of Dorothy H. Jenkins' most recent book. In its two hundred and twenty-three pages are presented data and growing experience on annual flowering plants from Acroclinium to Zinnia. There are such time-saving features as listings of plants by color; for special uses as edging, background, fragrance, cutting, winter bouquets; and a "calendar of chores." The book develops its subject from planting to gathering, giving information on when and how to plant, cultivating, watering, special care and the control of pests. Description of species and varieties of annuals is meaty and readable. The publishers are M. Barrows and Company, Inc., New York.

Wm. E. Jordan

THE TIMING OF INSECT CONTROL OPERATIONS

R. B. Friend

Connecticut Agricultural Experiment Station

GARDENING operations should be carefully planned if the best results are to be obtained. A little forethought may save many vegetables as well as much work. This applies not only to seection of the garden site, choice of the varieties of vegetables to be grown, ferilization and cultivation, but also to the control of insect pests. In regard to pest control operations, proper timing is one of the essentials. By timing we refer to calendar dates, to the developmental stage of the plant, and to the life cycle of the insect. In it are involved such factors as the date of planting, reduction in numbers of the insect before plants are seriously injured and before outbreaks of insects develop, the stage of the insect most susceptible to the treatment, the avoidance of injury to plants by the insecticide, the avoidance of residues of insecticides, the stability of the insecticide, and the growth of plants.

Timing the Planting

By planting certain crops at certain times* insect injury may be avoided. Thus the first generation of cabbage maggot flies are active during the first part of May and lay their eggs at this time. It takes about a week for the eggs to hatch. Injury to radishes may be avoided by planting before April 1 or after May 20. Cabbage set after June 1 is not so seriously infested as early cabbage, set about May 1 or before that date. The cucumber beetle comes out of hibernation fairly early in the spring and is waiting to attack cucumbers, melons, and squash as soon as these plants appear above ground. Much injury can be avoided if these crops are not planted until after June 1, that is, after the population of adult beetles has declined. Snap beans are attacked by the Mexican bean beetle, which has two generations a year. It is possible to plant beans so that the plants come up after the first generation of adult beetles (the hibernating generation) has declined and the crop is harvested before the second generation becomes very injurious. To accomplish this, plant the seeds during the first three weeks of June. Sweet corn can also be planted, between May 20 and June 15, so that it matures when few corn borers are present. The squash vine borer lays its eggs on squash plants during the month of July. If summer squash is planted after July 1, much injury by this pest may be avoided. If Hubbard squash is planted before May 15, the vines will be well established by July 1 and the attack of the vine borer is not so likely to be serious. Leafhoppers on potatoes become injurious by the middle of the summer. Irish Cobblers planted as early as possible (in April) can usually be harvested before hopper burn becomes serious. The seed corn maggot attacks seeds of beans, corn, squash and some other vegetables, particularly when the soil is cold and wet. Planting after June 1 avoids much of this injury.

Timing the application of insecticides

In determining at what time to apply insecticides the obvious aim is to make the application when the best results will ensue. Let us consider first the relation of timing to the prevention of injury to the plant and to the development of those excessive populations which we call outbreaks, as these two phenomena are closely related. The control of the striped cucumber beetle is a good example of the necessity for close timing. These beetles literally swarm on young plants as the latter emerge from the ground and will even attack the seedlings below the surface if the soil cracks open. A delay of only a day or two in the application of an insecticide may mean the total loss of the planting. In the case of the control of the cabbage maggot the treatment, whatever it is, should never be delayed until the plants show signs of attack, for it is then too late. All treatments aim at preventing oviposition or preventing survival of young larvae. Even though a wilting plant later recovers, it never forms a good head. In the case of the control of the Mexican bean beetle the insecticide could well be applied when most of the egg masses have hatched and before the larvae have become well grown. This would eliminate the young larvae before they caused much damage. It should be remembered that very young larvae do not feed as extensively as those that are older and are generally more susceptible to insecticides. Moreover, a given number of larvae will cause more damage on small plants than on large ones. If we set an average date for applying insecticides to control the bean beetle with what has been said above in mind, then early beans need treatment about June 7 and 21, late beans about July 29 and August 9 and 20. Pole beans may need all treatments. The number of treatments and the length of time between treatments in this case are based on the period during which beetles lay eggs and the length of time it takes the eggs to hatch.

---

* The dates mentioned in this article refer to the region around New York City.

Be Early!

The control of aphids on potatoes and cauliflower offer good examples of the necessity of proper timing in order to prevent the development of an outbreak. A few aphids on either of these plants are in themselves of no great consequence, but as progenitors of future populations they are very significant. Aphids reproduce very rapidly, especially if the weather is fairly warm. If the application of insecticides is delayed until these insects are abundant, then serious damage may occur, even though a large proportion of the aphids are killed. It is the actual number of aphids that survive treatment that is of importance here, not the proportion killed. When aphids become abundant, even a high percentage of mortality may well leave so many survivors that the number of aphids on the plants rebounds to an injurious level in a very short period of time. Moreover, cauliflower plants are quite susceptible to injury by aphids, and an excessive population may well cause a definite retardation of growth so that good heads do not develop, even though the aphids are eliminated in time to permit survival of the plants. The application of insecticides should be coordinated with the development of the aphid population so that a large population never develops.

The control of the European corn borer in sweet corn offers a striking example of the necessity of timing the application of insecticides according to the stage of development of the pest. Corn borer eggs are laid on the leaves and stalks of the plant, and the young larvae bore into the developing tassel, ear shoot and the stalks at the leaf junction. Although they migrate to other parts of the plant in a later stage of development, the control operation, if it is to be successful, must prevent this first entry. Hence for good corn borer control, the insecticide must be present on definite parts of the plant when the eggs hatch. Although the time of egg deposition varies somewhat from year to year, according to weather conditions, insecticides should be applied about June 10, 15, 20, and 25 to control the first generation, and about August 5, 2, 19, and 26 to control the second gen-ration. The number of applications and ne interval between them is set by the viposition period of the adult moth and ne incubation period of the eggs.

It is probably true that most insecti-ides have some deleterious effect on lants, and under certain conditions this nay be pronounced. Spraying or dusting n very hot humid afternoons may cause eaf scorch and should be avoided. Bor-eaux mixture applied to potatoes has a endency to reduce the yield of tubers nd should be used the minimum number f times necessary to control blight and eafhoppers. Its application may well be elayed in many cases until the first week n July and four or five applications may uffice unless late blight is rampant.

Care in the use of insecticides

Insecticides which are poisonous to nan should not be present on crops that re to be eaten. Beans and cabbages are ases in point. If a material toxic to nan is used to control the Mexican bean eetle on snap beans, then no application hould be made after the pods form. Otherwise the pods may be poisoned. abbages are infested with three species f caterpillars which feed on the heads. hese can readily be killed by insecticides ontaining arsenic or fluorine, but such nsecticides should not be applied after he heads are about three inches in diame-er, even though the outer leaves are rimmed off and discarded. Of course in he case of both the bean beetle and cab-age worms, insecticides non-toxic to man hould be used if available.

The stability of the insecticide may be factor of importance in controlling cer-ain pests. The adult Japanese beetle is revalent during July and August and is njurious to many herbaceous and woody lants. A rotenone-containing insecti-ide, whereas effective in controlling this est, deteriorates after a few days' exposure on the plant and hence soon loses its effect. This necessitates frequent applications, and the interval between them is governed by the stability of rotenone, usually a matter of about five days.

Many plants grow rapidly during the period when pests are active and the frequency of application of an insecticide is governed by the development of this new growth which must be protected. As an example we may consider the striped cucumber beetle. This insect not only eats the leaves of cucumber vines but also infects them with the bacterium which causes wilt. It is controlled by the use of stomach poisons. As the vines develop, the new growth should be kept covered with the poison. This means frequent applications during the period of beetle activity and active plant growth.

The importance of proper timing in relation to the efficiency of operations can be readily understood from what has been said above. Without it the material and labor may be wasted and the injury caused by the pest may progress unimpeded. We have said nothing about the specific material to be used for the control of various insects, but whatever material is employed, put it on the plants at the right time. To be sure, this entire question is more or less affected by the nature of the insecticide, and this may be of considerable significance. Its toxicity, stability, and adhesion to the foliage are all important. For example, the insecticide commonly called DDT has the distinct advantage of being quite stable and of adhering well in addition to being very toxic to insects. In fact, it may be too stable and adhere too well for some purposes. If you are going to kill insect pests, kill them at the proper time, remembering that it is not necessarily dead insects that reflect the efficiency of your operations, but healthy plants. Correct timing will accomplish the best results with the least effort.

* * *

CHEMOTHERAPY—A METHOD OF PLANT PEST CONTROL

Treatment of plant ills by injection of chemicals

E. M. Stoddard

Connecticut Agricultural Experiment Station

CHEMOTHERAPY as a method of plant pest control is not new, but an abundance of new organic chemicals and some new angles on the problem have currently given a new impetus to investigational work on this most interesting of pest control methods.

When the doctor gives us some pills to take three times a day after meals we think nothing of it. If we read of plants being given medicines to cure their ills, we marvel at the strides of science or perchance think somebody is a bit "off the beam." But, in the case of both you and the plant, the method is chemotherapy—the treatment of a disease with chemical reagents that are toxic to the causal agent without seriously injuring the patient. So after all we are only proposing to treat plant ills the same way we successfully treat our own ills.

Although the word chemotherapy has been used in the title, we prefer, out of deference to the dictionary, to call this method of treatment plant injection. Chemotherapy implies the internal application of chemical reagents for the treatment of diseases only and later we will want to discuss insect control and other uses of internal chemical treatments. Perhaps while we are defining terms it would be well to define the word disease as it will be used in this discussion. We will consider a disease as any departure from health exhibiting recognizable symptoms from any cause whatever.

A new idea?

Injecting a plant with chemicals seems at first thought to be something very new and very much up to the minute, but in a long look back one sees this method being tried for various purposes early in the 12th century. Writings of Hadj de Grenade in 1158 describe methods of imparting perfumes and flavors in fruits and colors to flowers by the introduction of spices and dyes in solid form into the plant. The next record one finds of plant injections is in the fifteenth century when Leonardo de Vinci recorded in his notes a method of liquid injection of arsenic and realgar into trees. This, he said, was "capable of making the fruit of the tree poisonous or making it wither." The materials used indicate that the purpose of the experiments was to kill insects and control diseases.

For the next three centuries there appear but few records of plant injection and these mostly are aimed at producing especial flavors or perfumes in fruit. Although in this period we find one record of a mixture of "pepper, laurell and incense" mixed in wine being recommended for killing "wormes" in the wood, probably the worms were wood-boring insects. In 1765 *The Rural Cyclopedia* (Wilson) contains the following: "A curious method of destroying insect on trees and shrubs, by means of mercury, was invented in 1765 by a person in Hereford, and was speedily adopted by members of the Society for the Encouragement of Art. The invento pierced the branch of a plum tree slopingly with an awl through the bark an part of the wood, but not the pith, an poured into the hole a drop or two o mercury, and stopped it up with a sma ooden plug; and he found that on the xt day all the insects dropped off from at branch, and, in a day or two more, om all the other branches, and that the ee continued in full vigour, and throve ell throughout the season."

These and other early tests on plant jection carried on with limited mate- als and more limited knowledge of plant iysiology and plant pests are mostly of storical interest and add little to our iowledge of plant injection methods. owever the purpose of many of these irly experiments was the same as the odern application of chemical injec- ons, namely to improve the condition of ie plant without causing undue injury it.

Following the publication in 1886 of ome successful results of injections of ilorotic acacia trees with iron salts, the udy of plant injections for the cure of hysiological and fungous diseases, and or insect control has steadily increased. n the last fifty years we find many orkers trying injections with a wide ariety of materials for the cure or pre- ention of various fungus and nutritional ls of plants as well as for control of isects.

How are the chemicals injected?

Very good you say, but how is a plant iduced to take its medicine? This is ccomplished in various ways, the earliest iethod being to split a branch or root, ut the dose of chemical in the split, tie p the wound, and cover well with a mix- ure of clay and dung. Such treatment as rather rough on the tree and boring oles in the trunk and branches was later ubstituted for the splitting. Into these oles was put the material being injected nd the holes plugged up with a wooden lug. A further refinement of the boring echnique was the attaching of a reser- oir of the desired solution by means of ietal and rubber tubing to the hole bored n the tree. For small trees and herba- eous plants the reservoir can be at- ached to the end of a cut stem through which solutions will be absorbed. All these methods have a common disadvantage in that the chemicals are not absorbed evenly throughout the plant and control is incomplete. Many chemicals are readily absorbed through the leaves and by the roots and later we will discuss some very practical applications of these two methods of plant injection. After some little experience in this field we are of the opinion that to make plant injection practical it will be necessary to introduce chemicals by absorption through the roots or by the leaves. This will necessitate determining what materials will be absorbed by the plant patient, and watering them with solutions, putting the chemicals on the soil, or spraying the dose on the foliage. Also the material used must control the pest and not kill the plant.

Extent of use

Plant injections are being currently tried for the control of fungous and virus diseases of plants, for insect control, and for the correction of nutritional diseases. In recent work on all these diverse phases of pest control by plant injections an encouraging measure of success has been attained. Among the recent experiments on fungous diseases we may note control of bleeding canker of maple and partial control of Dutch elm disease as well as some promising results on a vascular disease of eggplants. In our own work it has been found that peach trees can be immunized against the virus of X-disease by injections of chemicals, the most successful of which is one of the sulfa compounds. A Selenium compound applied to the soil from which it is taken up by the plant has successfully controlled red spider and more recently it has been found that the population of bean beetles was reduced on bean plants watered with a solution of Dithane at a .5 per cent concentration. This same material controlled leaf hoppers on potatoes.

At the moment the most practical results from plant injections are in the cure of nutritional diseases. Some of the successful early work on plant injections was the cure of chlorosis (lack of green coloring matter) of the foliage of various trees by the introduction of iron salts. A chlorotic foliage condition of tung trees in Florida has been successfully controlled by applications of zinc either as a foliage spray or on the soil. "Internal cork" of apples is being cured by applications of boron to the soil. Spraying the foliage of apple trees with magnesium sulfate (Epsom salts) cures a serious foliage trouble due to magnesium deficiency. All three of the above mentioned plant medications are recognized commercial practices in tung tree plantations and apple orchards.

How do the injected chemicals work?

After the discussion of how and for what plant injections have been used, it may be rightfully asked how these injected chemicals act on the causal agent of the diseases, or the insect which they control. To this question an answer is not immediately available, but one may offer the current theories on the matter. In the case of fungous diseases the action may be one of two things or a combination of both. The chemical may kill the causal fungus, antidote the injurious toxins produced by the fungus or both. Chemical action on viruses is even more obscure, but it is believed that either the virus is destroyed or inactivated or the plant mechanism is conditioned so that the virus is not able to multiply sufficiently to produce visible symptoms. A quick answer to the method of action on nutritional diseases is to say the deficient element is supplied and everything is under control, but presumably it is not as simple as that. However, with considerable lack of knowledge as to just what does happen to the growth processes of the plant from the lack of a necessary element, it is perhaps better to let the quick answer suffice and not become involved in speculations.

In conclusion we may say that the curing of plant ills by internal dosing is, with a few exceptions, still in the experimental stage. The day may not be too far off when you can get a prescription filled to cure the ills of your favorite plant or apply internal remedies on a commercial scale to farm crops but, with the exception of some of the afore mentioned deficiency diseases, that day is still "around the corner." However, with an accumulated fund of knowledge of the causes of disease and habits of insects, and a supply of chemicals heretofore unavailable, we believe that this age-old method of plant medication will be made to produce useful results.

BOOK NOTICE

Perennials Preferred, by Helen Van Pelt Wilson, is a useful book, replete with data on those plants which grow "through the years." It contains information on the designing of borders, on the growing of the plants, on types of material for seasonal blooming, as well as ten handy lists giving data on colors, shade-tolerance, fragrance, tolerance of drought, of heat, of seashore or of city conditions and other information of practical aid to the experienced as well as the beginning gardener. Well indexed, this book of 256 pages bears the 1945 imprint of M. Barrows and Company, Inc., New York. W. E. J.

DISEASE CONTROL IN THE HOME GARDEN

Cynthia Westcott

"The Plant Doctor"

THE "why" of gardening is never so important as in disease control operations. Too many gardeners apply sprays and dusts indiscriminately without regard to necessity, time of application, choice of material, or possible injury. Too many plants suffer from mistaken kindness, from overzealous owners who apply patent remedies without thinking of why, what, and when.

Contrary to general belief, summer spraying or dusting with fungicides (chemicals to control plant diseases caused by fungi or bacteria) is seldom practical or even desirable in the small home vegetable garden. Insecticides, yes, for there are many pests that must be kept down in this manner, but there are easier and better ways of conquering most diseases of vegetables. These include: 1, choice of resistant varieties (e.g. rust-resistant Washington asparagus, yellows-resistant cabbage); 2, purchase of certified seed (especially potato or tomato); 3, seed treatment before planting to prevent damping off and root rots (Arasan for some crops, Spergon for peas, beans and lima beans); 4, spacing rows far enough apart to allow air circulation around each plant (a great help in avoiding soft rot of turnips, carrots, etc.); 5, keeping down weeds to prevent transfer of virus diseases; 6, use of insecticides to reduce insect carriers of disease; 7, removal of spotted leaves or an occasional whole plant before infection can spread; 8, avoiding picking or cultivating beans, celery and other vegetables while plants are wet enough to allow germination of the fungous spores you scatter around as you work; 9, cleaning up all refuse after harvest and burning this potential inoculum. Since it is easier to control disease with your head rather than with a sprayer on your back, spraying comes down to tenth place in this list of do's and don't's for the ususal home vegetable garden. If, however, you are going in for late potatoes, you must spray with Bordeaux mixture or other copper compound, or dust with copper lime dust, in a wet season. A tricky crop like celery may require copper sprays or dusts, and copper is combined with rotenone in a special dust available for cucumbers.

The same rules apply in the flower garden up to a point. You plant wilt-resistant asters or rust-resistant snapdragon; seed treatment is sometimes beneficial; phlox or rose mildew is partially avoided by planting where there is good air drainage; iris well spaced, the tops cut back somewhat after flowering and the top of the rhizome exposed to the sun, is less susceptible to soft rot; asters may be screened with cheesecloth to keep out yellows-bearing leafhoppers; spotted iris or delphinium or rose leaves should be picked off as soon as noticed; fading tulip flowers or blasted peony buds are removed before they can rot in the ground and produce black resting bodies (sclerotia) of the botrytis blight fungus; delphiniums surrounded with the reddish, mustard-seed-like sclerotia associated with crown rot are taken up with surrounding soil and the hole treated with bichloride of mercury or other disinfectant; a general fall clean-up of dead annuals, spent tops of perennials, is always in order.

The success of the flower garden is, however, measured in terms of beauty rather than dollars and cents, and here chemical treatment in addition to sanitary measures is usually justified. The cost of protective spraying need not be set against the market value of a pound of string beans in midsummer; you can also add the all-summer satisfaction of looking at thrifty plants in full flower and leaf rather than yellowed or leggy leafless individuals with sparse bloom.

Mildew is probably the easiest disease to recognize in the flower garden, and it is usually readily controlled. The fungus grows as a network of fine white threads over the surface of leaf or bud, sending down little suckers into plant cells for nourishment and sending up into the air chains of spores, microscopic in size, which give the characteristic powdery appearance. Since the different species of mildew fungi grow almost entirely outside the plant it is possible to kill them even after the white coating starts to form, but it is wiser to get a head start. Fine sulfur dust is a specific against mildew; wettable sulfur sprays or some of the combination copper sprays are also satisfactory. Mildew on Dorothy Perkins and Crimson Rambler roses starts on the foliage some time in May and, if allowed to develop, will cover the buds and prevent flowering in June. Phlox mildew starts in June on the variety Miss Lingard, and towards July on later varieties; lilac mildew shows up towards the end of July in most seasons; mildews on chrysanthemums, dahlias, dephinium, hybrid tea roses, zinnias are more prevalent in August, September and October.

The disease known as rust is also recognized by its color, often the rust-red of oxidized iron. Hollyhocks have orange-red spore pustules protruding from the under surface of the leaves (the same area yellowish on the upper surface) while snapdragon rust produces pustules more nearly chocolate brown. Since the rust fungus is entirely inside the leaf, except for the visible spore pustules, it is harder to control than mildew. Protection depends on having a chemical covering the foliage before the spore arrives and starts to grow into the leaf. Sulfur dust is probably first choice, provided it covers the under side of leaves. But don't depend on dusting to control snapdragon rust completely: start with resistant varieties. And augment the dusting program on hollyhocks by removing and burning infected leaves as soon as noticed.

Spraying or dusting roses against black spot probably pays more dividends than any other chore in the flower garden. It produces bushy shrubs rather than leafless horrors, it ensures some bloom all summer, a magnificent crop of fall flowers lasting almost through November (sometimes into December in the Brooklyn Botanic Garden), and practically guarantees winter survival with a moderate hilling up with earth. The black spot fungus reacts to sulfur, to copper and to some of the new carbamate materials not yet generally available. Control is easy provided you start in time, get proper coverage, and spray or dust often enough to keep susceptible leaf surfaces continuously protected. Although spotted leaves do not show up much before June first it is safest to start treatments the first of May. While the plants are growing rapidly and there is much rainy weather, applications may be required every 5 or 6 days, but ordinarily once a week is enough for practical control. In some areas the intervals between treatments may be lengthened in midsummer, but this is seldom possible along the Middle Atlantic Seaboard. The spore germinates and gets inside the leaf where it cannot be reached with chemicals, within 6 hours of continuous moisture. In our section we may go long periods without rain but we usually have enough fog or dew at night and early in the morning to make up that 6 hours of moisture. It is better to play safe and spray regularly.

Rose lovers argue violently as to whether you should spray or dust roses, should use copper or sulfur. The so-called Massey dust, with 9 parts of sulfur combined with 1 part of arsenate of lead is used by many gardeners to control black spot, mildew and chewing insects. It is excellent in cool weather but may burn rather badly if applied at noon on a hot summer day. The dust must be carefully applied, puffed up from underneath through *dry* bushes to prevent unsightly residue on the foliage and discolored flowers. If preferred, this sulfur combination may be obtained colored green (Pomo-Green) and with nicotine added for aphids. A really bad infestation of aphids or leafhoppers will probably call for one or two extra sprays in addition to dusting. Copper used as a dust is too unsightly for roses but in some sections 10 per cent of a copper compound has been added to sulfur dust with good results. Bordeaux mixture and similar copper sprays will, when used in cool weather at ordinary strengths, cause some leaf spotting or defoliation, but some copper sprays are safer than sulfur in the heat of summer.

My personal preference, and I stress the word personal, is for the three-in-one combination (Tri-Ogen) which depends on copper as a fungicide and includes both a stomach poison and a contact insecticide so that all rose troubles are taken care of in one operation. While this does not give complete control of black spot in every garden in every season it gives practical control on a year after year basis. It is unsafe on some species roses in spring, may injure a few polyanthas all summer, but it seems to be particularly safe for hybrid teas when sprays must be applied during the day regardless of high temperatures, and there is seldom any disfiguring residue on buds or open flowers. In the long run the choice of dust or spray, of sulfur or copper, depends on its feasibility under your own particular circumstances. Probably in another year or two we shall have other and perhaps better chemicals from which to choose.

DEFOLIATION

Our work with Victory Gardeners has brought to light some amazing misconceptions concerning plant life—especially the rôle of leaves in the plant's economy. We had great difficulty in convincing one enthusiast that he could not persist in cutting off the leaves of beets to use for greens and expect them to produce edible roots.

Another very common error is that of cutting off or reducing the foliage of carrots to make them produce larger roots. When abundant leaves are produced and roots fail to swell normally at the proper time it usually is an indication of unbalanced nutrients in the soil with an excess of nitrogen and insufficient phosphorus and potash. Obviously cutting off the leaves will not bring about the desired result.

Almost universal is the amateur gardener's practice of cutting leaves off tomatoes "to let the sun get at the fruits to ripen them," and in some cases to promote fruitfulness. Actually, unlike apples and some other fruits, tomatoes are not dependent upon light for their coloring and if too much exposed they may suffer from sun scald. The leaves furnish food for the fruit, so, far from promoting fruitfulness, their removal works in the opposite direction. Now as an additional reason for refraining from defoliation, we have a report of some recent experiments carried on by Ray W. Barratt, Plant Pathologist of the Connecticut Agricultural Experiment Station, which indictate that the fewer leaves a tomato plant has in relation to fruit the more susceptible it is to attacks by defoliating diseases, which suggests that the more leaves that are cut off by hand the greater will be the loss by disease of those remaining.

M. F.

MODERN SPRAYS & DUSTS

An account of some of the latest developments in fungicides and insecticides

L. Gordon Utter

Plant Pathologist, Phelps Dodge
Refining Corp.

THE control of plant diseases and insect pests has been for many years a prerequisite to the growing of good crops and the protection of ornamentals. Today, control measures are even more important because of the increased demand for food supplies. Consequently, farmers, commercial vegetable and fruit growers, victory gardeners, and also amateur gardeners are highly interested in the use of materials which will efficiently protect their plants from diseases and insects and thereby increase production.

In the modern control program, certain of the older types of fungicides and insecticides still find a place, but they are frequently meeting keen competition from the newer materials. The trend in present-day research is continuing toward the discovery and development of more new compounds which at some future date may broaden our present control procedures. What a joy it will be to the grower, if an all-purpose spray or dust appears someday which involves a single material. In the meantime, it is not advocated that control measures be suspended.

What is required of sprays and dusts

Regardless of whether the fungicide and insecticide is old or new, it must conform to certain requirements for modern acceptance. These are: 1. High effectiveness against the disease or insect pest for which it is recommended or, even better, control over a wide range of different pests. 2. Able to be used as a spray or dust. 3. A minimum of injury to foliage or fruit and non-reduction in crop yield. 4. Adherence to foliage and resistance to weathering after application. 5. Easily prepared in a spray and effective in small quantities. 6. If a fungicide, it must be compatible when used in combination with insecticides and *vice versa*. 7. The quantity required and the price must be economically practical.

Old and new fungicides

In the control of plant diseases, sulfur in various forms and Bordeaux mixture, a chemical combination of copper sulfate and lime, are the oldest and best known fungicides. Sulfur was used extensively as far back as 1848, while Bordeaux entered the field about 1885. Both fungicides continue to play an important part in present day control measures and they are so widely accepted that their future usage appears assured. It, therefore, does not seem necessary to go into details concerning them.

In using fungicides, as well as insecticides, there is always the danger that injury may occur on some plants. This may be due primarily to climatic conditions or to unfamiliarity by the user of the materials involved. It is questionable whether such possible injuries overshadow the demonstrated ability of the fungicides and insecticides to control the diseases or insects concerned, which would otherwise be more detrimental to the plants. However, with the fungicides, this very point has resulted in the development of a group of copper compounds called the "basics," "low solubles" or "insolubles." The basic copper sulfates appear under such trade names as Tribasic, Basi-cop, Spray-cop, etc., vhile Cupro-K and Compound A are ilustrative of copper oxychloride, and -O-C-S of the copper oxychloride sulates. In addition, there are the copper xides which appear under such names as uprocide and Yellow Cuprocide. Due o war-time restrictions, however, these articular compounds are not generally vailable. The "low solubles" may range n metallic copper content up to 86 per ent and therefore can usually be used n smaller quantities to equal the copper ontent of Bordeaux. This is possible ecause the copper sulfate utilized in reparing Bordeaux contains 25 per cent metallic copper. While "low solubles" have the advantage of being used alone in a spray mixture, their performance may often be increased by the addition of a suitable sticking agent. Dusts, also, can be readily prepared with many of these materials. The application of the various "low solubles" generally corresponds to that for which Bordeaux is recommended. Considerable work is now in progress toward improving these compounds and developing new copper and other metallic fungicides which may prove highly important in future control programs.

Synthetic fungicides

The most recent advances in fungicides have occurred in the field of synthetic organic compounds. In fact, it has been said by some investigators that significant changes may be expected during the next five years in favor of such compounds. At the present time the organic fungicides fall into three main groups: Dithiocarbamic Acid, Quaternary Ammonium, and Quinones. Needless to say, the chemistry of these compounds is intricate and would only confuse the interest in their applications.

The commercially available and tested fungicides of the Dithiocarbamic Acid group are *Fermate* (Ferric dimethyl dithiocarbamate), *Methesan* and *Zincate* (Zinc dimethyl dithiocarbamate) and *Dithane* (Disodium ethylene bisdithiocarbamate). These fungicides have been reported as giving effective control of various vegetable and certain fruit diseases. For some reason, however, the best performance of Dithane on such crops as potatoes and celery requires the addition of zinc sulfate and hydrated lime. Zincate in some tests has indicated a similar requirement. Both Zincate and Dithane have interestingly shown some insecticidal properties. Of the Quinones, Spergon is now commercially available and is being used against various vegetable diseases with indicated success. Other related compounds are still undergoing trial.

The Quaternary Ammonium compounds such as Isothan Q15 and Puratized N5D are water soluble materials which work well with lead arsenate. They have been found to give particularly effective control against apple scab and bitter rot at very low concentrations.

The full extent of usefulness of these compounds and other related ones of the same group are still dependent upon further experimentation. It is now apparent that many of the organic fungicides show promise but it is unlikely that they will eliminate the continued use of copper and sulfur fungicides. There is, also, the indication that a given organic fungicide may be rather restricted in the diseases it will control. That fact, plus the present cost of these materials may limit their wide adoption, even though the amounts used in a spray are frequently less than with other fungicides.

Old and new insecticides

Insecticides, like the fungicides, have their old standbys which are of current importance. Therefore, it seems appropriate to merely mention such materials as arsenic and nicotine compounds. To be sure, newer forms are now available but their usage conforms rather closely to the recommendations long followed. Consequently, other insecticides will be of greater interest because of their more recent applications.

Pyrethrum and rotenone are of particular interest because they are nonpoisonous to warm-blooded animals. Pyrethrum is derived from the dried flowers and buds of *Chrysanthemum cinerariaefolium* and is processed for market in the form of liquid extracts or dusts. Due to its valued use as an insecticide by the armed forces, it is now restricted as a plant protectant. Derris or rotenone is obtained from various plants found in the Old World tropics as well as South and Central America where it has been used as a fish poison. It, also, is prepared in liquid extracts and dusts. Both pyrethrum and rotenone have given successful control of chewing and sucking insects on vegetable crops. Rotenone is somewhat slower acting than pyrethrum but it also tends to repel certain insects. Pyrethrum and rotenone, unfortunately, lose their effectiveness upon exposure to light and air. Consequently, they must be applied at approximately weekly intervals to insure satisfactory control.

Cryolite (Sodium fluoaluminate), both in the natural and synthetic form, is finding increased popularity for the same usage as the arsenicals. It is comparatively non-injurious to plant foliage and has proven particularly effective for controlling codling moth and bean insects. Cryolite may act as a stomach or contact poison or repellent and thereby may serve as a partial substitute for pyrethrum and rotenone on vegetable and other crops. It also has the advantage of being used as a spray or dust.

Synthetic insecticides

Among the synthetic organic compounds are several which merit insecticidal use. Loro and Lethane are liquid contact insecticides which have come from the thiocyanate group. They are used against various sucking insects ordinarily controlled by nicotine and in certain dust mixtures they may partially take the place of rotenone and pyrethrum. The Di-nitrols comprise a group of compounds which have been derived in the dye industry. Di Nitrol, Elgetol, Dow DN, etc. are representative of some of the commercial products available. These insecticides have proven valuable for killing aphid eggs, various scale insects and red mites. However, their application is generally restricted to the dormant period of plants where, with the exception of Elgetol, they must be combined with dormant oils. DDT (Dichloro-diphenyl-trichloroethane), the organic compound made famous as a louse powder for protecting our armed forces and the civilian populations overseas, has promise as an agricultural insecticide. Tests conducted during the past two years have indicated that DDT is highly effective in controlling various vegetable insects, the codling moth, and Japanese beetle. Further work is required, however, before recommending or releasing this material for general use. It is worth watching.

Oil an important insecticide

Oil sprays also have an important role in insecticidal control, especially against scale and mites on fruit trees and ornamentals. They include the miscible oils, oil emulsions, and emulsifiable oils and are used both as dormant and summer sprays. These oil sprays are made up according to different specifications and are normally sold under the trade name of the manufacturer.

Availability and warnings

It is obvious that a wide choice of modern sprays and dusts is offered to meet the exacting requirements of efficient pest control. The various materials mentioned often can be purchased at local supply houses, but there may be instances where a desired product is available only at the larger agricultural dealers. It is also necessary to point out that many of the materials used in pest control are poisonous to humans and animals and that due caution must be exercised in handling and storing them.

WITHIN THE BROOKLYN BOTANIC GARDEN

C. STUART GAGER MEMORIAL FUND

The many friends of Dr. C. Stuart Gager, Director of the Botanic Garden since its founding in 1910 until 1943, have urged the establishment of a suitable memorial to his great accomplishments. A fund of nearly $10,000 has been contributed by individuals and organizations.

Many suggestions regarding a fitting memorial to him have been considered. At its April 5, 1945 meeting, the Governing Committee of the Garden decided to establish "The Gager Memorial Fellowship." As the income of the fund becomes available, fellowships may be awarded to qualified persons for the pursuit of research in botany, horticulture, or botanical education at the Botanic Garden.

UNUSUAL BIRDS IN THE GARDEN

Gardeners who have a pool, pond, or running brook may have the opportunity to see interesting bird life—ducks, herons, grebes, shore birds, the kingfisher.

Nearly every season, toward the end of July, one or more green herons visit the lake, brook, and waterlily pools of the Botanic Garden. The lily leaves and labels afford excellent perches for watching and waiting—and enjoyment after success. Thousands of visitors to the Garden observe them, few knowing what they are or whence they came. By a listener, strange tales are heard, how the bird was brought from far-away lands by a soldier or sailor.

Great Blue Herons are annual visitors for a short period. In the summer of 1943 an immature bird spent several weeks in July to September fishing in the lily pools and in the lake, becoming very tame, but still wary.

Green heron waiting for opportunity.

Green heron poised to strike the unwary.

HEART'S DESIRE

Sidney Russell Tilley

[Summertime is rose time, so it is appropriate, in this summer issue of Plants & Gardens, to include an article on roses by Sidney Russell Tilley who has grown roses in the Brooklyn Botanic Garden since the Rose Garden was first planted in 1927. Also of interest are excerpts from an interview with Mr. Tilley by the Brooklyn Eagle's George Currie. Ed.]

INGRAINED in every one of us is the love of flowers. No matter whether we live in the open country or are trapped in the midst of a great city, there is within us an appreciation of flowers, and especially of the rose. Sometime in life, to many of us comes the desire to possess a garden and to grow a rose or two for ourselves. It is not permitted to all to have a large piece of ground where expensive ideas can be carried out, but there is always a yearning for some little secluded spot where roses and only roses are grown. What satisfaction will be felt in tending the plants and watching the blooms unfold in their full and perfect beauty. The form is noted, the texture of the petals, the color of the bloom and its sweet fragrance. The form or shape is varied, some are long and pointed, some globular, some cupped, some compact and some expanded. Some varieties have delicate thin petals through which the sunshine glistens, others with petals of more substance refract its beams.

The roses of bygone days were limited in color to pink, white, and purple but today, through the work of the hybridizer, they take on all the colors of the rainbow. As Dean Hole says:

"What a diversity, and yet what a harmony, of colors! There are White Roses, Striped Roses, Blush Roses, Pink Roses, Rose Roses, Carmine Roses, Crimson Roses, Scarlet Roses, Vermilion Roses, Maroon Roses, Purple Roses, Roses almost Black and Roses of a glowing Gold."

The yellow color is not included in his list, for a clear yellow was not then known. In the gardens of the late nineties the hybrid perpetual was the most popular rose and that type could not boast of one variety of a yellow hue. The species, *Rosa foetida* (Austrian Brier Rose), *R. foetida persiana* (Persian Yellow), *R. hemisphaerica* (Sulphur Rose) and a few of their nearby hybrids were the only types of yellow roses then grown and these were what the Dean called "Roses of a glowing Gold." It was not till 1920 when the late Joseph Pernet-Ducher, the great French hybridizer, produced Souvenir de Claudius Pernet that we had a double rose of clear yellow.

Who can define rose fragrance? While some blooms will exude what is called real rose fragrance, others will give out an odor of spices and others a rose fragrance combined with the faint scent of lemons. A few of the rose species have glands on the under surface of the leaves which give out a sweet fragrance after a summer shower but none so mindful of a garden scent as the old Sweetbrier Rose, *R. eglanteria*. Rose fragrance is all too ethereal and fleeting in this climate of ours but perhaps it is this property of odor, more than any other characteristic, that has endeared the rose for generation after generation.

Under different conditions of time and weather roses alter in appearance. In the early mornings of June when the dewdrops glisten in the rising sun, the roses smell so fresh and sweet. In the quiet of the evening, the setting sun throws long shadows over the garden and the flower color deepens as the sun goes down. The rain comes and gives a different aspect. Some types hold their heads up to catch the refreshing shower while others bow as in a prayer of thankfulness. In spring when the leaves unfold, the varied fresh green colors and reddish brown tints create a new sense of beauty and a feeling of satisfaction that the plants have escaped the rigors of another winter.

So, for whatever reason we want to grow roses, we scheme to get some bit of ground where we can achieve our heart's desire.

GEORGE CURRIE'S BROOKLYN

Excerpts from an article in *The Brooklyn Eagle,* Apr. 29th, 1945

"High time it was the other day that Floriculturist Currie should hie himself back to the Brooklyn Botanic Garden to pay a call upon the rosebush he adopted only a month ago. But I have to report with blushful chagrin that for the life of me, I couldn't find my foster rosebush child.

Here was a pretty kettle of fish, forsooth. It seemed just too silly for words to have mislaid such a big, strapping plant. Then I fortunately ran smack into Mr. Sidney Russell Tilley, 73, who wears a cap and a white mustache and a twinklingly candid blue eye. He also puffs a companionable pipe and sensibly combats the wind with a sheep-lined coat.

They call him 'Rose Garden Tilley' at the Botanic Garden and it is a title which carries with it an affectionate respect. He was very comforting, as, walking with a slight stoop acquired from years of bending over, he led me up the path.

'Here it is,' he said. By now it had its little green name-plate neatly staked. It read: 'Mme. Marie Curie, presented by Jackson-Perkins Co.'

The garden was astonishing, for, believe it or not, some of the roses are already in blossom. Most of these early bloomers run from yellow to rich cream. But the cinnamon rose, a warm red, is out, too. One of Mr. Tilley's April pets is the Spinossissima altiaca, if I haven't misspelled it. [You have, Mr. Currie! Its correct designation is *Rosa spinosissima altaica.* Ed.]

Rose gardening in the middle of Brooklyn is 'intensive' and 'exacting,' it turns out, from March to December. This would explain, naturally, why the Currie roses used to be the neighborhood's laughing stock and so much duck soup for aphids and Japanese beetles. It would also explain how, year after year, Mr. Tilley is able to put on so pretty a show in the formal garden just across the street from the park."

"HOWS" AND "WHYS" OF HORTICULTURE

On two days, March 6 and 8, the Brooklyn Botanic Garden, with the co-operation of the State Institute of Agriculture at Farmingdale, L. I., offered a short intensive course on the "hows" and "whys" of horticulture. The course was designed especially to be of assistance to employees of the Botanic Garden and of the New York City Park Department, but many interested "outsiders" were welcomed at the meetings. The lectures were given by three members of the Institute of Agriculture: Messrs. Harvey Gray, Clarence E. Lewis and Louis Pyenson; also by Messrs. Montague Free, George S. Avery and Miss Ellen Eddy Shaw of the Garden staff. Among the subjects discussed were: How Plants Grow; Plant Identification; Transplanting; Pruning; the Control of Insect Pests and Diseases; Fertilizers; Lawn-Making.

About 500 persons attended the course. In response to a written questionnaire which was distributed, the majority voted that the course be repeated next year; but a large number voted for one lecture in the morning and one in the afternoon to be followed by discussion groups. A large majority voted for a longer course.

NO GREAT LOSS WITHOUT SOME SMALL GAIN!

The Botanic Garden suffered severely from the hurricane in the fall of 1944. But the loss was not entirely unmitigated, for the wood from the fallen trees was cut, split, and burned in the heating plant, thus providing a modicum of heat for plants and people after our supply of coal was exhausted early in April.

Fringe-tree, *Chionanthus virginica,* a valuable native plant for our gardens.

AMONG THE CONTRIBUTORS TO THIS ISSUE

Harold A. Caparn, Consulting Landscape Architect of the Botanic Garden from January 1, 1912 until 1945. He designed the Rose Garden, Horticultural Section and many other Garden features. His other professional activities include the Campus of Brooklyn College, and the planting design in connection with the House Office Building in Washington, D. C.

Dorothy H. Jenkins, formerly a member of the Garden Staff, is Garden Editor of the New York Times. She is co-author with Helen Van Pelt Wilson of "Enjoy Your House Plants" and author of the recently published "Annual Flowers From Seed Packet to Bouquet," noticed in this isuue.

Henry B. Aul, Landscape Architect on the staff of the Garden Page of the New York Herald-Tribune, is widely known for his lucid illustrated articles on garden planning.

Hester M. Rusk, Instructor in Public Education at the Garden, interested in native flora and ferns.

Elizabeth Clarke, Curatorial Assistant in the Department of Plants, is at the present time especially interested in annuals and herbaceous perennials.

Dr. Louis Pyenson obtained his Doctor's degree at Cornell University and since 1939 has been Instructor in Plant Protection, State Institute of Agriculture, Farmingdale, Long Island. He has written a valuable, well illustrated book on "Pest Control in The Home Garden," published in 1944 by the Macmillan Co.

Dr. R. B. Friend, Entomologist at the Connecticut Agricultural Experiment Station since 1924, and Connecticut State Entomologist since 1939. Interested in economic entomology, taxonomy of insects, especially Diptera. Author of many scientific papers and popular articles.

E. M. Stoddard, since 1909 a member of the staff of Connecticut Agricultural Experiment Station. Author of numerous papers on diseases of economic plants, especially fruit trees.

Dr. Cynthia Westcott obtained her Doctor's degree in Plant Pathology at Cornell University. She has developed a practice in the field of fungous diseases and pest control. Recently, as Agent of the United States Department of Agriculture, she has been investigating the methods of control of the azalea flower spot in the South.

Dr. L. Gordon Utter. As Research Assistant at Brooklyn Botanic Garden, he obtained his Doctor's degree at Columbia for investigations along pathological lines. Since March 1944, he has been Plant Pathologist with the Phelps Dodge Refining Corp.

ROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

Autumn, 1945

ayout of the Small Place

—

Autumn Coloration

—

Chrysanthemums

—

ant Hormones and Cuttings

—

Seed Germination

OL. I NEW SERIES NO. 3

BROOKLYN BOTANIC GARDEN
OF
THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

Officers of the Institute

EDWARD C. BLUM
Chairman, Board of Trustees

ADRIAN VAN SINDEREN
President

WALTER H. CRITTENDEN
First Vice-President

CHARLES PRATT
Second Vice-President

SIDNEY W. DAVIDSON
Third Vice-President

EDWIN P. MAYNARD
Treasurer

JAMES E. GIBBONS
Secretary

Ex Officio Members of the Board

The Following Officials of the City of New York

THE MAYOR THE COMPTROLLER
THE COMMISSIONER OF PARKS

Botanic Garden Governing Committee

PHILIP A. BENSON, *Chairman*

MISS HILDA LOINES, *Vice-Chmn.*
EDWARD C. BLUM, *Ex officio*
WILLIAM G. CREAMER
WALTER H. CRITTENDEN
LEWIS L. FAWCETT
MRS. LEWIS W. FRANCIS
ANDREW J. GONNOUD
WALTER HAMMITT
WILLIAM T. HUNTER
EDWIN P. MAYNARD
ROBERT MOSES, *Ex officio*
ALFRED E. MUDGE *
JOHN C. PARKER
DONALD G. C. SINCLAIR
ADRIAN VAN SINDEREN, *Ex officio*

Director of the Botanic Garden

GEORGE S. AVERY, JR.

---

* Deceased Aug. 23, 1945.

PLANTS & GARDENS

Opuntia tortispina

New Series Autumn, 1945 Vol. 1—No. 3

CONTENTS

Cover..........Chrysanthemum Virginia
Frontispiece..........Sugar Maple (Acer saccharum)
Announcement..........George S. Avery, Jr. 131
Layout of the Small Place..........H. Stuart Ortloff 133
Autumn Coloration..........Arthur Harmount Graves 135
Shrubs for Autumn Color..........C. F. Doney 138
Rooting Cuttings with Plant Hormones..........Elizabeth Bindloss Johnson 140

Chrysanthemums:

Chrysanthemums are Plastic..........Montague Free 145
Growing Large Chrysanthemums Outdoors..........Ernest L. Scott 152
Greenhouse Culture of Large-flowered Chrysanthemums..........George H. Gillies 155
Classification of Chrysanthemums..........Henry K. Svenson 160
Growing Hardy Chrysanthemums..........Henry E. Downer 161
Winter Hardiness in Chrysanthemums..........W. D. Holley 163
Hybrid Korean Chrysanthemums—Their History..........Alex. Cumming 165
Chrysanthemum Arcticum Hybrids..........V. R. De Petris 168
Producing New Chrysanthemum Varieties..........H. Roy Mosnat 171
Problems in Seed Germination..........Lela V. Barton 174
Knee Gardens..........George S. Avery, Jr., with Maud H. Purdy 182
Do Plants, Too, Have Cancers?..........Philip R. White 184
Within the Brooklyn Botanic Garden.......... 189
Among the Contributors to this Issue..........Page 3 of cover

Except where otherwise noted: drawings by Michelena LeFrere Carroll and Maud H. Purdy; photographs by Louis Buhle.

MONTAGUE FREE, *Editor*

Published quarterly at Prince and Lemon Streets, Lancaster, Pa., by the Brooklyn Botanic Garden, Brooklyn, N. Y. Entered as second-class matter, May 26, 1945, at the post-office at Lancaster, Pa., under Act of August 24, 1912. Subscription included in Botanic Garden membership dues. To others: $2.00 per year; $3.00 for two years.
Copyright, 1945, by the Brooklyn Botanic Garden.

Sugar Maple (*Acer saccharum*). See Autumn Coloration p. 135

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
1000 WASHINGTON AVENUE
BROOKLYN 25, NEW YORK
TELEPHONE: MAIN 2-4433

Autumn 1945

FRIENDS OF PLANTS & GARDENS:

The American countryside is probably nearer people's hearts than most of its man-made institutions. It symbolizes peace. Men have fought for their woods and hills, and many a man and woman returning from service in far places will welcome the crisp, cool days of autumn and the color of the trees in the woods and along the roadside. These are the tangibles we think about in connection with our country.

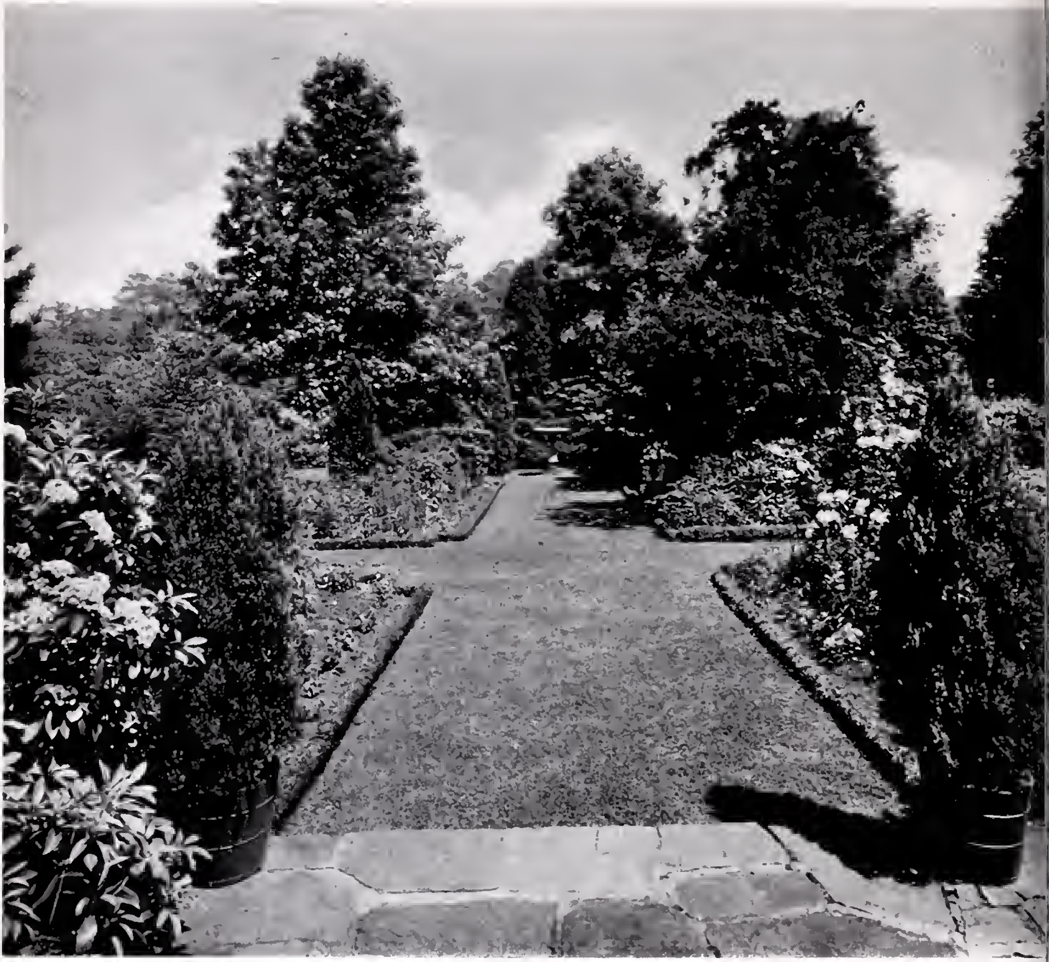
About this issue: Whether people know plants or not, most of them know chrysanthemums; hence the decision to feature them in this Autumn number. Chrysanthemums carry the torch of color far into the fall. The numerous and sundry other articles will be of almost certain interest to those with the earthy urge.

From time to time we want to present material about plants that is not concerned with gardens. Probably the most spectacular piece of biological (plant and animal) research in recent years has been on penicillin. It is one of the top discoveries of all time in the biological field. A lowly mold has produced a chemical substance that fights disease-producing bacteria to the death! The scientific frontier continues to advance and more discoveries equal to penicillin are coming.

But the story in this issue is about cancer-like growths in plants. A recent number of the magazine *Life* presented splendid pictures of plant tumors. We are including in this issue an authentic account of some of the work along these lines being done at one of the great biological research institutions in America. The material is presented in words and pictures that will be readily understandable to all.

Autumn greetings!

Yours sincerely,
George S. Avery, Jr.
Director



J. C. Maugans p

Layout of the Small Place—A simple suburban garden

LAYOUT OF THE SMALL PLACE

A simple suburban garden

H. Stuart Ortloff

Landscape Architect

ONE of the cardinal principles that should govern the design of small gardens is simplicity. Far too often amateur gardeners, in their enthusiasm, create gardens that are much too large and complicated in design for the size of their properties, and for easy maintenance. Any garden whose maintenance becomes a chore soon ceases to have the care it deserves and is no longer a thing of beauty.

Illustrated here by photograph and plan is a simple, forthright garden which can be adapted to many small suburban plots. The fairly wide central path leads directly from the living terrace of the house to a small circular area about a birdbath. This area is backed by an interesting planting of low evergreens (*Juniperus pfitzeriana*) and a group of trees made up of cedar, flowering dogwood, with a scarlet oak in the background, thus creating a focal point which is the climax of the whole garden scheme.

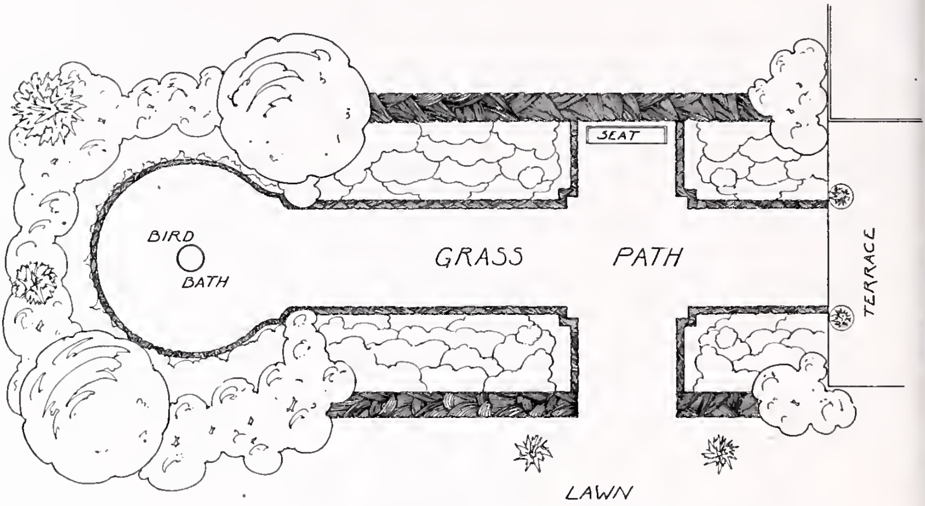
The borders on either side of the central path are, in the original garden, approximately eight feet wide. This measurement can, of course, be increased or decreased according to the amount of space available but the width should have a definite relationship to the overall depth of the garden if a pleasing sense of proportion is to be maintained. In borders where a fair amount of succession of bloom is expected a width of less than five feet is impractical.

The borders themselves are edged with dwarf boxwood, thus strengthening the feeling of line, and creating a definite pattern—two factors that are important in small garden design. The common tendency to create "informal" effects by the use of trailing or floppy plants along the edges of beds in the mistaken idea that it creates "charm" most generally creates disorder and distress.

The planting of these generous beds can always be a matter of personal preference, but in the original garden a spring display of tulips under-planted with pansies has always been effective. This effect was concentrated near the front edge and the middle and background were filled with carefully selected perennials to carry on the succession of bloom. A few peonies for accent, some hybrid delphinium, clumps of garden lilies, and for fall, chrysanthemums supplied the bulk of the planting. The space left by the tulips can be filled with a variety of low growing annuals. Again speaking of the original garden, heliotrope was used alone with a few lantanas for accent, thus blending and tying the whole scheme together. Other annuals were used throughout the border as fillers and to give a more complete succession of bloom. These were selected, of course, so that they complemented the existing groups of perennials.

This small garden had a background and enclosure (like all true gardens) secured through the use of a hedge of Japanese holly (*Ilex crenata*). Small groups of laurel, azaleas, and the small-leaved rhododendrons were used to break the rigidity of the hedges and relieve monotony. This background and enclosure served the purpose of shutting out the neighboring landscape and concentrating attention on the pleasing detail of the garden itself. At the same time it gave a feeling of privacy. Too many small gardens have to compete with the larger landscape and the activities of the neighborhood, and come off second best.

Thus on a very small plot of ground a very small garden was created which follows the tenets of good design: a central axis related to the house and adequately terminated with a focal point; background and enclosure to secure and hold a unified feeling; beds or borders wide enough to maintain a good succession of bloom. Even in the depth of winter this garden presented a pleasing picture for its definite pattern was accentuated by the permanent planting. The hedges and the tree background still functioned.



Planting plan for a suburban garden. *Henry B. Raymore*

* * *

AUTUMN COLORATION

How the leaves get their fall colors

Arthur Harmount Graves

ONCE more, in its course around the sun, the earth has passed through the fall equinoctial period, and as the nights begin to lengthen, and the days to shorten, a change comes over the face of all Nature. It is as if she foresees the rigorous ordeal of the coming winter through which she must pass, and is making preparations not to be caught napping.

Among the first of these changes are the new and often striking colors which the autumn foliage now assumes. We look for the beginning sometime in September, or in some of our trees, like the tupelo or pepperidge, even as early as August. But by October, field, meadow and forest are aglow with colors. The sumacs on the hill and the red maples in the low ground are crimson splashes in the landscape; and the browns, yellows, and reds of the oaks, sugar maples, birches and others of the countryside add a host of variations to the symphony of color.

The spectacle is of such marvelous beauty, especially in the Eastern United States, that it has achieved world-wide fame. Travellers from Europe, in times less hectic than these, often choose their dates for visiting this country when the autumnal coloration is at its height.

Temperature

What are the causes of this wonderful display? Perhaps the lower temperatures now prevailing deserve first place, for in cool weather very little chlorophyll (the green pigment of the leaves) is formed. The green of chlorophyll is not a "fast" color but quickly fades, so that during the growing season new chlorophyll is continually being formed in the leaves. But with the cooler weather the plants' chlorophyll factory slows down, as, indeed, do all the vital processes in plants. As a result of this condition, and here is the important point, all of the other substances present in leaves show their true colors.

Among the important substances which produce autumn coloration are the carotinoids, pigments which vary from pale yellow to orange red; xanthophylls which are yellow; and anthocyanins which are from red to blue. Carotinoids are always present in leaves, but their presence is masked by the green chlorophyll. The anthocyanins are found mainly in the autumn, but in some cases, as in the young leaves of the red maple, are present in the spring. Certain varieties of beech, plum, hazel, and barberry show anthocyanin colors throughout the growing season. The following table (from Textbook of Botany, by Transeau, Sampson and Tiffany, p. 28, 1940) gives the principal pigments in leaves with their chemical composition.

Pigments	*Apparent Color*	*Chemical Composition*
Chlorophyll a	Blue-green	$C_{55}H_{72}O_5N_4Mg$
Chlorophyll b	Yellow-green	$C_{55}H_{70}O_6N_4Mg$
Carotenes	Yellow to red	$C_{40}H_{56}$
Xanthophylls	Yellow	$C_{40}H_{56}O_2$
Anthocyanins	Red to blue	Various combinations of C, H and O

Sweet Gum—*Liquidambar styraciflua*

Light

Another cause of autumnal coloration is the brilliant sunlight of "October's bright blue weather." And since the air is clearer outside the large cities we find the colors in the countryside more brilliant. (Of course this factor acts in conjunction with the failure of the leaves to manufacture chlorophyll.) In New York City, for example, it has been definitely shown by experiment that much of the intensity of sunlight is absorbed by the smoke and dust particles of the city air. Some of us will remember the haze that envelopes a large city when viewed from some distant eminence, and everyone knows the differential effects of sunlight in the city and out of it in causing sunburn. The photochemical effect of sunlight on the reddening of fruit is well known. Sometimes, one sees a clear demonstration of this where a leaf close to a red apple has protected it from such photochemical action, and left its yellow print on the apple.

Heredity and Other Factors

Finally we must not overlook the part that heredity plays in all these changes, changes which have been going on for ages and are Nature's adjustment to the environment.

For most brilliant autumnal coloration, experience has shown that a moderately cool moist fall season is better than a warm dry one. In the latter case the yellows and browns are most prominent.

Why do we in this country have a more brilliant autumnal display than exists in Europe? One reason seems to be that we have a large variety of maples, oaks, sumacs, etc., which naturally show brighter colors. In England there is only one native species of oak (lately split up into 2 species) and the sycamore and Norway maples which are not in the least flamboyant. Other reasons may be that in our climate the drop in temperature in the fall is more pronounced and the sunlight more intense.

Since the chemical constitution of each species of tree is more or less constant, so its own particular autumn color is constant. One can, for example, easily recognize at a distance the peculiar purplish shade of the leaves of the white ash, and the gorgeous purple-crimson tints of the maple-leaved viburnum form a royal tapestry in many of our woodlands. The yellows, such as those of the hickories and birches, are so similar that they are hard to differentiate at a distance. The reds of the sumacs, with heir feathery leaves, are easier to recognize and the different species show different hues. Even the poison sumac *Rhus vernix*) is magnificent in its autumnal dress, as some autumn leaf collectors who are not botanically minded know to their grief.

Outstanding Colors

For first honors for autumnal coloration we nominate the sugar maple (*Acer saccharum*) and the sweet gum (*Liquidambar styraciflua*). The first, an "old timer" in New England, may be seen in majestic rows bordering both sides of many an old New England village street, and in October presents an unforgettable picture, some of its outer foliage tinged with flaming crimson, but toward the center of the tree of a deep golden hue as if perchance the foliage were undergoing a monstrous deepseated internal fire.

The sweet gum is a more southern tree growing naturally as far north as southern Connecticut, but capable of cultivation much further north. The variety of hues brought out by the autumnal changes in this tree baffles description—purples, reds, yellows, and often some of its pristine green color. It is truly magnificent.

Sometime in the fall a layer of thin, weak, corky cells—the "absciss layer"—forms across the base of the leaf stalk where it joins the twig. Then comes in early November a long, hard rain soaking and weakening this layer, so that with a gust of wind the leaf, with a final farewell flutter, parts company with the tree, to go "the way of all flesh."

* * *

An attractive foundation planting. Home of Mr. and Mrs. G. Howard Conklin, Huntington, L. I.

SHRUBS FOR AUTUMN COLOR

Leaf coloration in fall should be considered as well as flowers and other assets

C. F. Doney

IN the first issue of PLANTS & GARDENS we discussed the shrubs whose fruits bring color and interest to the garden in the fall. Of almost equal decorative value are the shrubs and small trees whose foliage takes on bright color in the autumn. We all are enthusiastic admirers of the gold and flame of our woods and hillsides in October—their beauty makes a strong impression on us and we may travel some distance to see a particularly effective display. It is odd then that we make so little effort to bring these colors into our own gardens. While the average garden can never approach the grandeur of an autumn hillside it can at least suggest it and be in keeping with the season. Even one or two bright shrubs can go a long way in pepping up a garden whose other occupants have wound up their seasonal affairs.

In the city, shrubs seldom color as intensely as they do in the country or suburbs. Chinese sumac (*Rhus chinensis*) for instance, in the cleaner air of the country can be of arresting brilliance while in the city the leaves may drop with scarcely any change in color. Those shrubs then that do color well in the city should be of interest to many gardeners. It should be kept in mind that the pigments that give the red coloring to the leaves develop best in clear bright sunlight and only a few shrubs, as the maple-leaved viburnum, develop the red-purple pigments in the shade.

Though red is the most eye-catching of the fall colors, it is more effective when combined with yellow; and both colors are enhanced when green is used as a background or in association. One of the shrubs that turns yellow early in the season is the common spice-bush (*Lindera Benzoin*) which grows well in sun or shade and likes moist soil. It is good in naturalistic plantings and is particularly effective when the golden-leaved plants are dotted with their bright red berries.

Another shrub that turns yellow early in the fall is fringe-tree (*Chionanthus virginica*). While not a first class ornamental it is useful as a lawn specimen or or in large shrub borders. It has feathery white flowers in the spring and the pistillate plants bear clusters of blue berries. The golden leaves of fringe-tree blend beautifully with bronze and copper chrysanthemums.

Our native sweet pepperbush (*Clethra alnifolia*), which also likes moist soil, is a slender, upright shrub of about six feet. In late July or August its branches are tipped with upright clusters of fragrant white flowers and the leaves begin to yellow soon afterwards.

Since the yellow pigments are not dependent on bright sunlight shrubs growing in semi-shaded situations can be as golden as those growing in the open. The yellow leaves of yellow-root (*Xanthorhiza*) blend well and make a very effective autumn combination with winged euonymus and English ivy.

A vine with yellow foliage is bittersweet. Both the American species (*Celastrus scandens*) and the Asiatic (*C. orbiculata*) have garden value, they are of vigorous growth and have attractive orange-red fruit but both are very subject to attacks of scale insects and should be planted only where they can be controlled.

The shrubs with red autumn coloring are appreciably more numerous than those of garden value with yellow foliage.

Just as the barberries differ in their fruit-ng characteristics so do they differ in heir fall coloration. The common Japanese barberry (*Berberis Thunbergii*) can be depended upon for a compact mass of rich red color over several weeks.

Though a small tree rather than a shrub our native flowering dogwood is so outstanding that it must be mentioned. The bright red berries ripen early in the fall and they are followed in a short while by wonderfully rich shades of red in the leaves.

American smoke-tree (*Cotinus americanus*) has little to recommend it during the spring and summer but it amply makes up for this in the fall when its oval leaves take on such shades of scarlet as to make it one of the outstanding plants in the garden.

The cotoneasters vary in fall color but one that has proved satisfactory year after year is *C. divaricata*, a handsome compact shrub of around six feet whose small, glossy leaves turn deep wine-red.

The hawthorns comprise an endless number of species, but only a few of them are of garden value. Outstanding is Washington thorn, a large shrub or small tree that is interesting most of the year but particularly showy in September and October when it is gaily decked out as for a holiday with shiny orange fruits and glowing orange and scarlet leaves.

While perhaps not so conspicuous as many other shrubs in the fall *Enkianthus campanulatus* assumes shades of orange and red that are in keeping with its air of dignity and refinement. Being in the Heath Family it likes acid soil and combines well with azaleas and rhododendrons.

In late October and early November one of the brightest spots in the Botanic Garden is a planting where the flaming red or crimson of the dwarf winged euonymus (*Euonymus alata* var. *compacta*) makes a striking combination with the bright green of an underplanting of English ivy.

Sorrel-tree—*Oxydendron arboreum*

An uncommon shrub but one with many good qualities is *Fothergilla major*. Besides its white flowers in spring the rounded, slightly coarse leaves never fail to contribute their share of yellow, orange and scarlet of the autumn pageant.

Sorrel-tree, or sourwood (*Oxydendrum arboreum*) is a native plant which we see too rarely in cultivation. A large shrub or small tree to around 20 ft., it has drooping clusters of white flowers in July and brilliant scarlet foliage in the fall. Slightly moist acid loam suits it best and it is effective used with mountain laurel, rhododendrons or azaleas.

Among the viburnums are many that color attractively in the fall but for the average home landscape *V. dilatatum* is the most useful. Averaging 6 or 7 ft. in height and attractive in flower and fruit, its dark green leaves begin to turn red in early autumn and are effective for several weeks.

ROOTING CUTTINGS WITH PLANT HORMONES

Elizabeth Bindloss Johnson

THROUGH countless centuries man has propagated those plants which contributed to his wealth, health, security and happiness. Various methods of propagation were used. Pliny's Natural History, written about 79 A.D., mentions the use of "slips," suckers and cuttings in producing new plantings of grape and olive. Today many of the horticulturally important varieties of trees, shrubs and herbaceous plants are propagated from cuttings, for vegetative propagation is a simple operation and, what is most important, preserves the characteristics of the parent plant which are often lost in plants raised from seed.

In the case of root cuttings and most leaf cuttings both new roots and new shoots must be formed if a new plant is to develop. In stem cuttings, however, only roots need be regenerated. Thus this type of cutting is used more commonly than other types. The capacity to regenerate organs is not confined to any particular group of plants; deciduous or evergreen, woody and herbaceous plants all have the same potentialities. However, the ease with which new organs form differs between woody and herbaceous plants and even on occasion between varieties of the same species. Plant hormones now enable us to root these difficult cuttings much more readily, decrease the time necessary for rooting, and result usually in better root systems than those found on untreated cuttings. The use of plant hormones is now standard horticultural practice.

What are Plant Hormones?—They are organic acids which control the growth and development of a plant. The chemist can now make a number of synthetic plant hormones which are being used in modern horticulture to an increasing extent These hormones are used variously to keep apples from falling prematurely stimulate fruit development without seed formation, retard the opening of buds in the spring, as well as to stimulate roo formation. Their many uses in horticulture are just beginning to be known

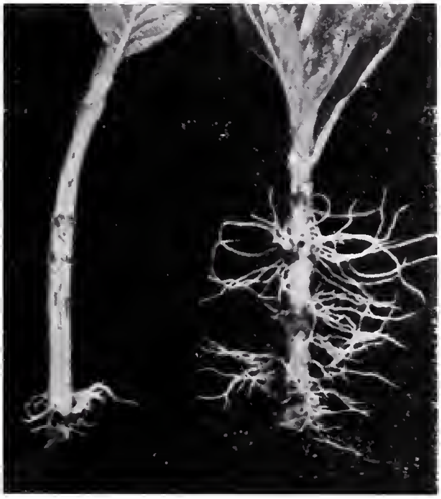
The chemist knows the root stimulating hormones as indoleacetic acid, indolebutyric acid, indolepropionic acid and naphthaleneacetic acid. Of these, indolebutyric and naphthaleneacetic acids are most widely used. Other recently discovered hormones are more active in stimulating root formation, but they also cause distortion of the roots and frequently inhibi the later growth of the leaf buds so tha as yet they cannot be used. It is expected, however, that related chemicals will be found which will be active roo stimulators and which will also act favorably on the rest of the plant.

Formerly the commercial hormone preparations were available in both a liquid and a powder form. The powder forms are so much easier to use, however, that they have largely superseded the earlier, liquid preparations. Such powders or dusts are packaged under various trade names and are available in most seed and garden supply houses Specific directions for treating cuttings of individual species usually accompany each package. Since woody plants roo with more difficulty than semi-woody or herbaceous plants, the hormones are prepared in different concentrations. Be sure to specify whether you wish to roo woody or herbaceous plants when you buy a commercial preparation.

How and When to Make Cuttings.—Before wasting time and money on hormones for rooting cuttings it is well to know a little more about the general prac ice of "cuttings," as it is called. It is rue that the use of hormones makes it ossible to root many plants at almost any ime of year, but there are certain seaons which are better adapted for rootng and further growth of cuttings than thers. Herbaceous plants may be rooted t any time of year provided they are iven sufficient protection and care. The isual practice with evergreens is to make uttings during October and the winter nd early spring months before growth as begun. Few evergreens are rooted y the average gardener, probably beause a greenhouse is usually necessary. uttings of deciduous trees and shrubs re readily made by the layman. Tips f leafy branches may be broken off in June, July or August. The wood should be mature enough to snap cleanly when bent, as limber and succulent growth fails to root readily. Segments other than terminal ones may be used, but where an abundance of material is available the use of terminal cuttings is recommended. Cuttings from mature wood taken from deciduous trees and shrubs after the leaves have fallen are known as hardwood cuttings. Such cuttings require controlled conditions of storage until they can be planted out of doors in the spring and hence are usually not made by the home gardener.

In determining the length of the cutting, one should remember that the leaves will continue to lose water and that there will be no roots to replace this water deficit for some time. Therefore, the length of most leafy cuttings is about 2 to 7 inches. Much has been written about the type of cut which is most satisfactory, the angle and position of the cut and the type of rooting medium most suitable. It is impossible to discuss the advantages and disadvantages of all these questions here. Suffice it to say that we now believe that the cut should be about ½ inch below an "eye" (node), but that the angle of the cut makes very little difference. As to the rooting medium, sand is probably used more than anything else. For plants which like an acid soil, however, such as arborvitae, azalea, blueberry, rhododendron, etc., a mixture of sand and peat moss or peat moss alone is best. The addition of peat moss to the sand aids in retaining a good water supply around the cutings, which should never be allowed to dry out. Until roots are established, cuttings should be shaded and, in large leaved forms, a third of the leaf area may need to be removed to prevent wilting and death.

How to Treat Cuttings with Hormones.—The preparation of cuttings for hormone treatment is similar for all kinds of plants. Hardwood cuttings of the proper length and without leaves need no further attention. However, leafy cuttings should have the lower leaves removed before treatment. The basal end of the cutting is first moistened and then dipped into the hormone preparation of the proper concentration for that particular cutting. The excess powder is then removed by tapping the cutting against the jar. Usually the powder adheres to the stem for about a half inch. Cuttings may be tied into bundles and dipped at



Hydrangea cuttings after twenty days in sand. Left: control. Right: Treated with heteroauxin 1 part in 10,000 parts of water one time into the hormone. However, results are likely to be somewhat irregular because the inner cuttings fail to receive as much hormone as the outer ones. Immediately after hormone treatment the cuttings should be inserted into the rooting medium, taking care that the hormone powder is not rubbed off. Cuttings should then be shaded to prevent wilting.

So little of the hormone is used that a small quantity will treat a great many cuttings. A quarter of a pound of hormone powder may be expected to treat 5,000 to 8,000 cuttings. Commercial preparations are packaged in various sizes so that smaller amounts may be purchased. The cost is small and the results justify the expense.

TABLE 1. SOME TYPICAL RESULTS OF TREATING CUTTINGS OF WOODY AND HERBACEOUS PLANTS WITH PLANT HORMONES. HORMONES WERE APPLIED TO THESE CUTTINGS IN WATER SOLUTIONS, BUT SIMILAR RESULTS ARE OBTAINABLE WITH APPROPRIATE HORMONE POWDERS.

Common Name and Scientific Name	Percent of Cuttings which Rooted		Time in Weeks Required for Rooting		Investigators
	Treated	Un-treated	Treated	Untreated	
WOODY PLANTS—*Evergreen*					
American Holly (*Ilex opaca*)	100	0	5	—	Hitchcock & Zimmerman, 1936
Canada Hemlock (*Tsuga canadensis*)	79	0	9	—	Yerkes, 1938
Globe Arborvitae (*Thuja occidentalis globosa*)	85	25	10	11–15	Yerkes, 1938
Mountain Laurel (leaves) (*Kalmia latifolia*)	80	20	19	19	Skinner, 1938
Rosebay Rhododendron (*Rhododendron maximum*)	100	20	13	—	Skinner, 1938
WOODY PLANTS—*Deciduous*					
American Bittersweet (*Celastrus scandens*)	100	0	7	—	Chadwick, 1937
Azalea (*Rhododendron molle*)					
var. Compte de Gomer	0	0	—	—	Skinner, 1938
" General Brailmont	100	100	8	12	" "
" Elizabeth	40	25	10	12	" "
" Frere Orbon	100	20	10	13	" "
Border Forsythia (*Forsythia intermedia*)	60	0	6	—	Oliver, 1938
Common Lilac (*Syringa vulgaris*)	88	10	3	—	Warner & Went, 1939
Red Maple (*Acer rubrum*)	50	0	11	—	Afanasiev, 1939
HERBACEOUS PLANTS					
Babysbreath (*Gypsophila paniculata*)	100	100	1	1	Tincker, 1938
Chrysanthemum (*Chrysanthemum* sp.)	100	100	2	Treated cuttings averaged 30 roots; untreated 2.5	Warner & Went, 1939
English Ivy (*Hedera helix*)	100	0	4	—	Tincker, 1938
Japanese Pachysandra (*Pachysandra terminalis*)	100	60	4	—	Chadwick, 1937

Typical Results Obtained with Plant Hormones.—Although results of hormone treatment of cuttings vary with the pecies of plant, time of year the cutting s made, the particular hormone employed and its concentration, a few experiments with certain woody and herbaceous plants will serve to illustrate typical results obtained with root hormones (table 1).

Unfortunately most investigators do not give data showing the time required for rooting of both treated and untreated cuttings. The usual statement is that hormone treatment speeds rooting. This s demonstrated in table 1 for 3 varieties of azalea and for globe arborvitae. Probably the greatest benefit of hormones is found in the narrow-leaf evergreens which root so much more quickly and produce better root systems than when untreated.

The most striking result of hormone treatment is observed in the increased percentage of rooting which, with few exceptions, is brought about in all groups of plants (table 1). Obviously hormone treatment offers little advantage to those plants which normally root easily. Note in the table, however, that the treated chrysanthemum cuttings possessed more than 10 times as many roots per cutting as untreated cuttings even though both groups rooted 100 per cent. This great abundance of roots following hormone treatment has been observed also in azaleas, rhododendrons and other woody plants in which transplanting of cuttings was formerly a delicate operation because of the small root systems. This difficulty has to a large extent been overcome by hormone treatments which produce numerous strong and vigorous roots.

One should not expect the impossible of these rooting hormones. Certain varieties normally fail to root readily. For example, Skinner in 1938 reported that one azalea variety (Compte de Gomer) failed to root at all with or without hormone treatment. Certain apple, grape and blueberry varieties are also almost impossible to root from cuttings. Skinner found that another azalea variety of the same species (General Brailmont) normally roots readily and continued to do so with the use of hormones. Still a third variety (Frere Orbon) greatly improved in rooting when given proper hormone treatment. This improved rooting is quite typical for most plant species and varieties.

It should be pointed out that hormones will not substitute for good care of cuttings. As yet no plant has been induced to root by the use of hormones which has not at some time rooted under optimum conditions without hormone treatment. By and large, however, the discovery of this group of substances has been and continues to be an ever increasing help to horticulturists. Rooting powders have a real place among your garden supplies.

REFERENCES

Afanasiev, M. 1939. Effect of indolebutyric acid on rooting of greenwood cuttings of some deciduous forest trees. Jour. Forestry **37**: 37–41.

Chadwick, L. C. 1937. Test chemicals in rooting cuttings. Results of experiments with growth-promoting substances in rooting cuttings of numerous woody ornamental plants. Amer. Nurseryman **66** (10): 7–9.

Hitchcock, A. E., and P. W. Zimmerman. 1936. Effect of growth substances on the rooting response of cuttings. Contrib. Boyce Thomp. Inst. **8**: 63–79.

Mitchell, J. W., and R. R. Rice. 1942. Plant-Growth Regulators. U. S. Dept. Agric. Misc. Publ. No. 495.

Oliver, R. W. 1938. Preliminary tests with plant hormones in the rooting of greenwood cuttings. Sci. Agr. **18**: 379–387.

Skinner, H. T. 1938. Rooting response of azaleas and other ericaceous plants to auxin treatments. Proc. Amer. Soc. Hort. Sci. **35** (1937): 830–838.

Tincker, M. A. H. 1938. Further experiments with growth substances and the rooting of cuttings. Royal Hort. Soc. Jour. **63**: 210–229.

Warner, G. C., and F. W. Went. 1939. Rooting of cuttings with indole acetic acid and vitamin B_1. 19 pp. Pasadena, Calif.

Yerkes, G. E. 1938. Treat cuttings with indolebutyric acid. Amer. Nurseryman **67** (9): 10–11.

CHRYSANTHEMUMS ARE PLASTIC

Montague Free

PROBABLY no flower exhibits such astounding variety in size, form and color as the chrysanthemum. The flowers range from the small button-like heads a half-inch or so in diameter of some pompon varieties, to the enormous aggregation of florets seen in the large-flowered exhibition types which may be a foot in diameter and as much in depth. The drawings by Miss Carroll (pp. 148, 149, 151) give some idea of the floral versatility of the chrysanthemum.

In the plant family *Compositae* to which the chrysanthemum belongs the flowers are borne in heads (the "flower" of common parlance) and typically consist of two kinds: the disk flowers ("florets") in the center, usually tiny and tubular, and the conspicuous ray flowers ("florets") around the outside, popularly referred to as petals.

Single chrysanthemums have the kind of flower head just described, but they may possess two or three rows of ray flowers without losing their "single" character in the eyes of the gardener. Actually there are all stages of transition between the strictly single types and those which are fully double. The size of the heads may be from less than 2 in. to more than 4 in. depending upon the variety and the method of culture.

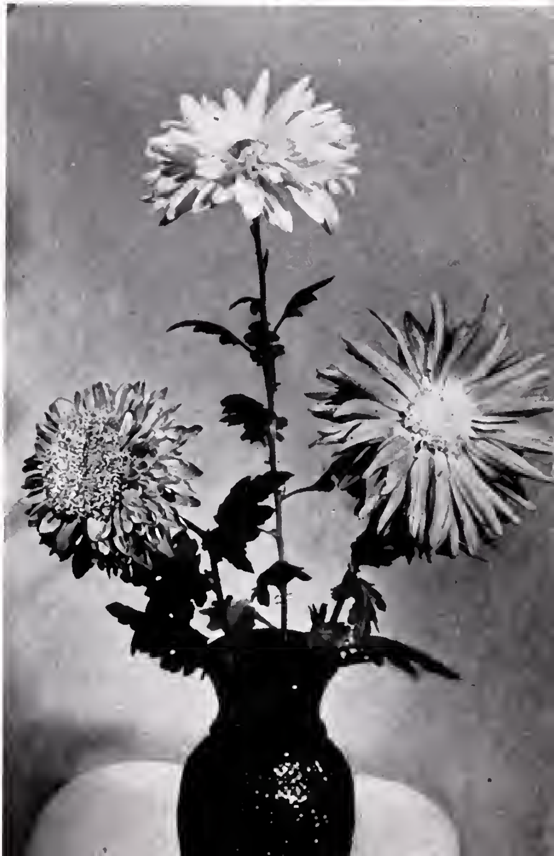
In the *anemone-flowered* types the disk flowers are enlarged and prominent but still retain their tubular character. The ray flowers may be arranged in a single row or in many rows. In some varieties they are regular, held horizontally and are comparatively short; in others they are curved and drooping.

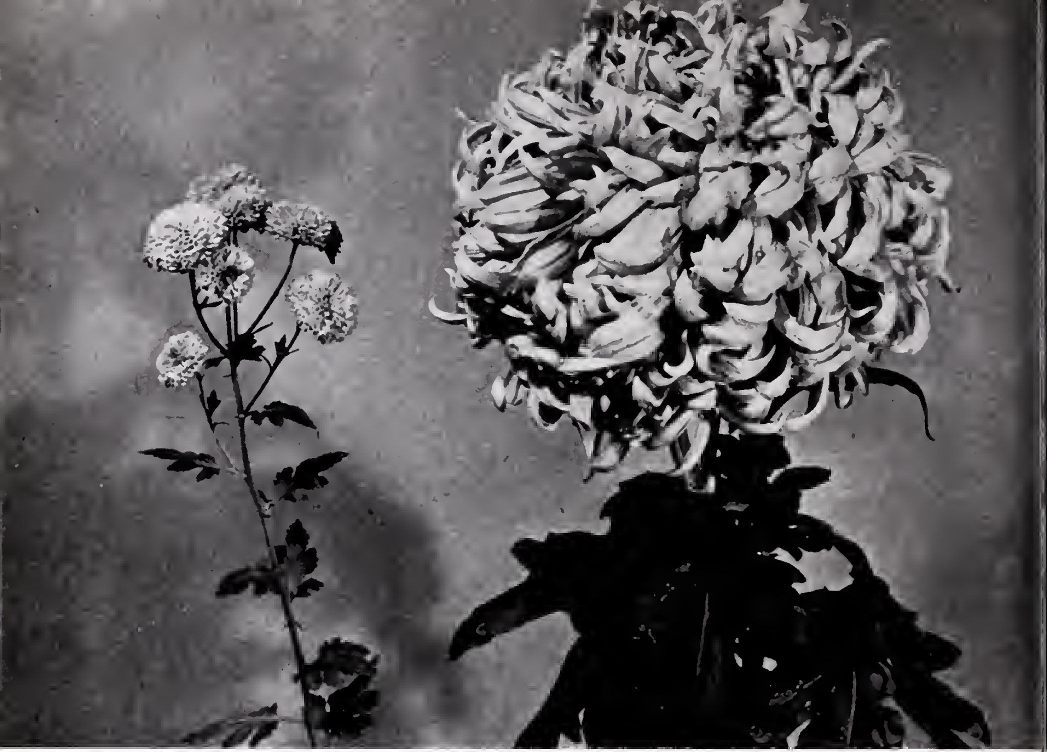
In the *double-flowered* kinds the disk florets are almost or completely absent and are replaced by ray florets. In size and form their flowers exhibit a bewildering variety. They may be no larger than a nickel, or as big as a child's head. The "petals" may be regularly or irregularly incurved, or they may be reflexed. They may be smooth or hairy, curled or straight; some are spoon-shaped, and some are quilled. In some of the fantastic varieties beloved by the Japanese the flower reminds one of a pastry brush, and some are so limp and spidery that the rays are supported on a wire framework (p. 146).

—Cathedral of Notre Dame modelled in growing chrysanthemums, cascade type. Note two large-flowered varieties grown to standard form

Courtesy Horticultural Society of New York. Bontrelle photo.

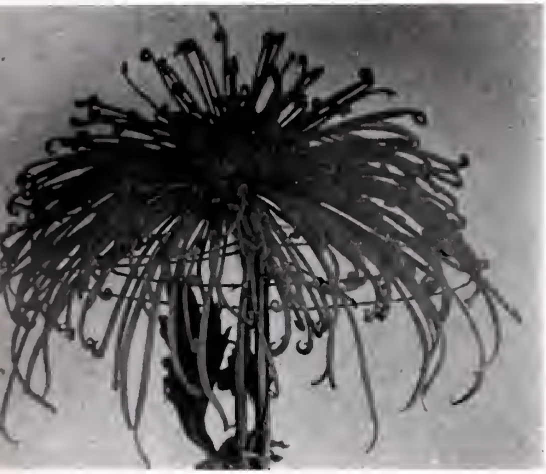
A "single," Prince Charming, and two anemone-flowered varieties, China Rose (left) and Dark Pink Frieda (right)





Small pompon; and Vermont, large-flowered exhibition type

Spidery type with curled petals



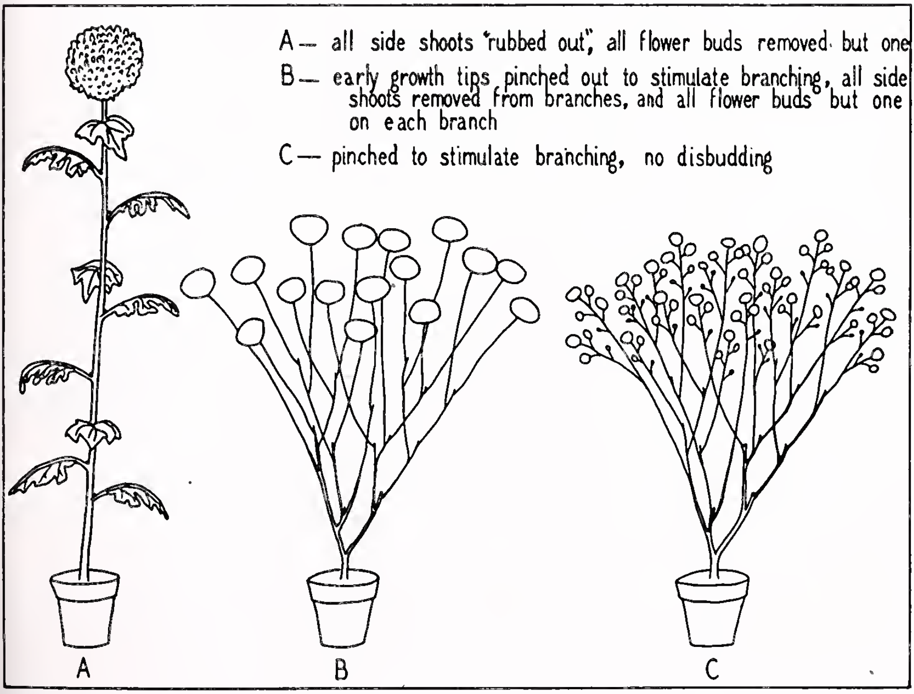
The infinite variations found among chrysanthemums depend partly upon inherited characteristics and partly upon the method of culture. By selecting a suitable variety, growing it with a single stem, and allowing only one flower bud to develop, enormous heads 6 to 12 in. in diameter may be produced. Using the same variety and pinching the tip from the rooted cutting to induce branching, a bushy plant can be produced with a flower 3 to 4 in. in diameter at the tip of each branch, if disbudded; or, each branch may carry a spray of flowers smaller in size if all buds are allowed to develop.

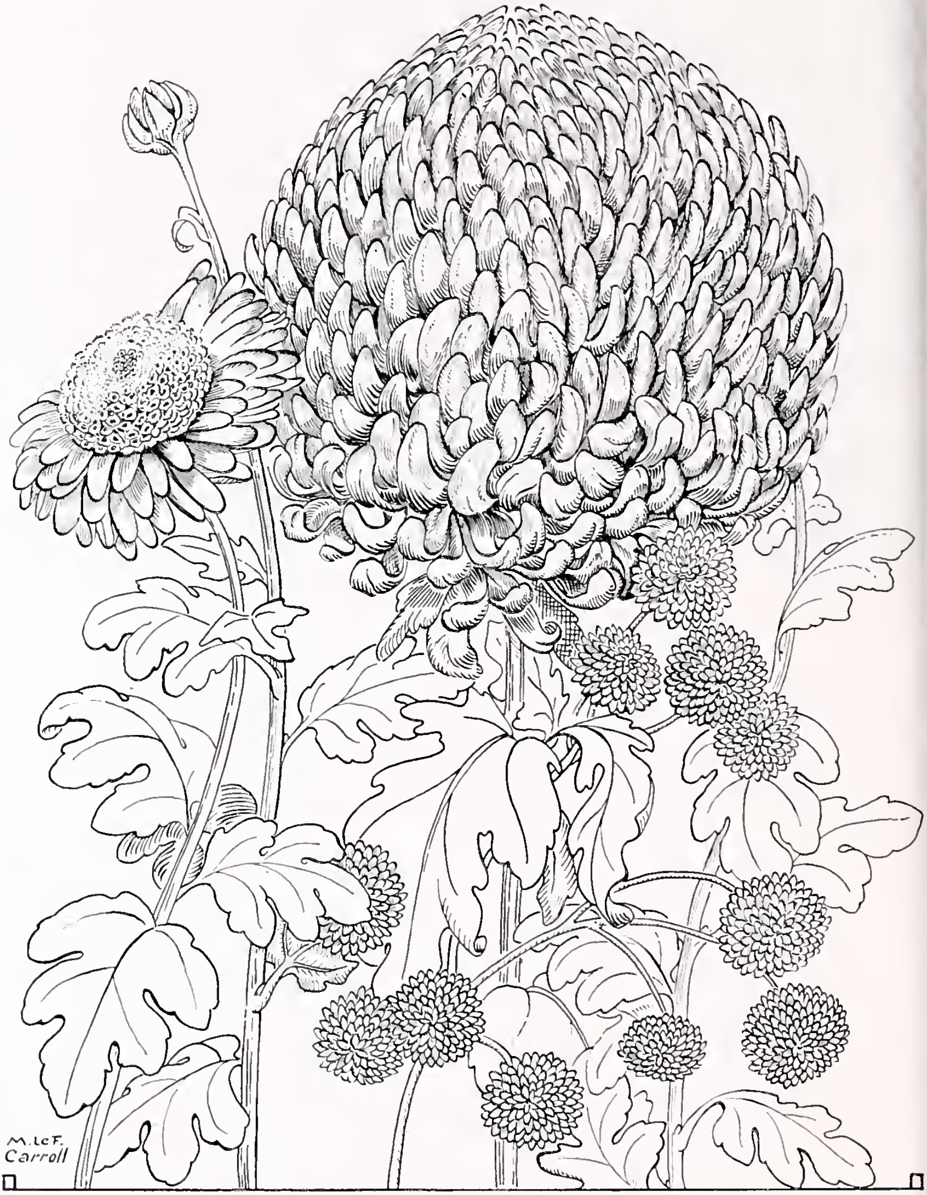
Differing Cultural Methods

The method of growing large-flowered chrysanthemums outdoors is told in the article by Ernest L. Scott (on p. 152) and their culture in the greenhouse is described by George H. Gillies on p. 155.

It will be noticed that each writer favors a different method of ensuring the selection of the bud which will produce the best possible flower, thus providing another illustration of the maxim "there is more than one way to skin a cat." Henry E. Downer tells how to grow hardy chrysanthemums; and W. D. Holley reports on winter hardiness in chrysanthemums.

By disbranching them, chrysanthemums may be grown with one, two, or three stems; by pinching out the tips of the growing shoots a plant of bushy nature can be produced; and by growing on a mature plant from the preceding year, pinching out growing tips, giving it ample root room and feeding it liberally, an enormous bushy specimen can be produced similar to those which were featured at the fall exhibitions of the Horticultural Society of New York held in the American Museum of Natural History. (See p. 157.) The record specimen was 16 ft. 10 in. in diameter and was exhibited by Mr. Adolph Lewisohn (John Canning, Supt.) in 1915. In Europe specimen bushes are sometimes grown by grafting a large-flowered variety of chrysanthemum on an understock of the shrubby *Chrysanthemum frutescens,* the marguerite or Paris daisy, so frequently sold as a potplant in florists' shops at Easter. One such grafted specimen was exhibited at the Paris Chrysanthemum Show in 1908 by Vilmorin-Andrieux. The 4-year-old understock was grown to a single stem to a height of 3 ft. and then allowed to branch. The branches were grafted with 288 scions which grew to make a plant 10 ft. in diameter carrying between 700 and 800 flowers. While huge plants such as this impel one to admire the skill of the cultivator, they are of little general use except for exhibition to excite the "Oh's" and "Ah's" of the beholders. For utility, plants grown in 5 in. pots are much more valu-

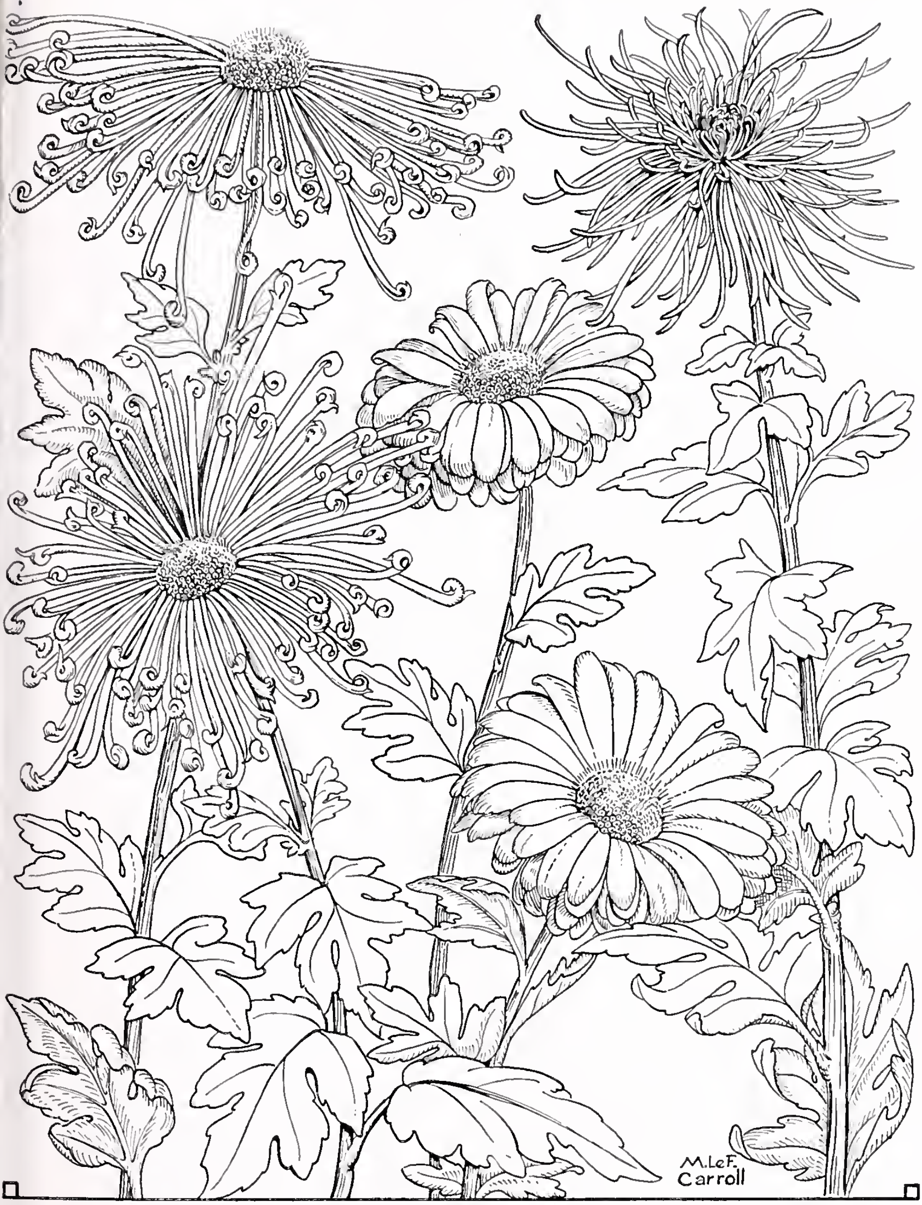

A — all side shoots "rubbed out", all flower buds removed but one
B — early growth tips pinched out to stimulate branching, all side shoots removed from branches, and all flower buds but one on each branch
C — pinched to stimulate branching, no disbudding
A
B
C



Types of Chrysanthemums

Anemone Large-flowered incurved

Small-flowered pompon



Types of Chrysanthemums

Spidery, curled petals Spidery

Single duplex

Cascade chrysanthemums

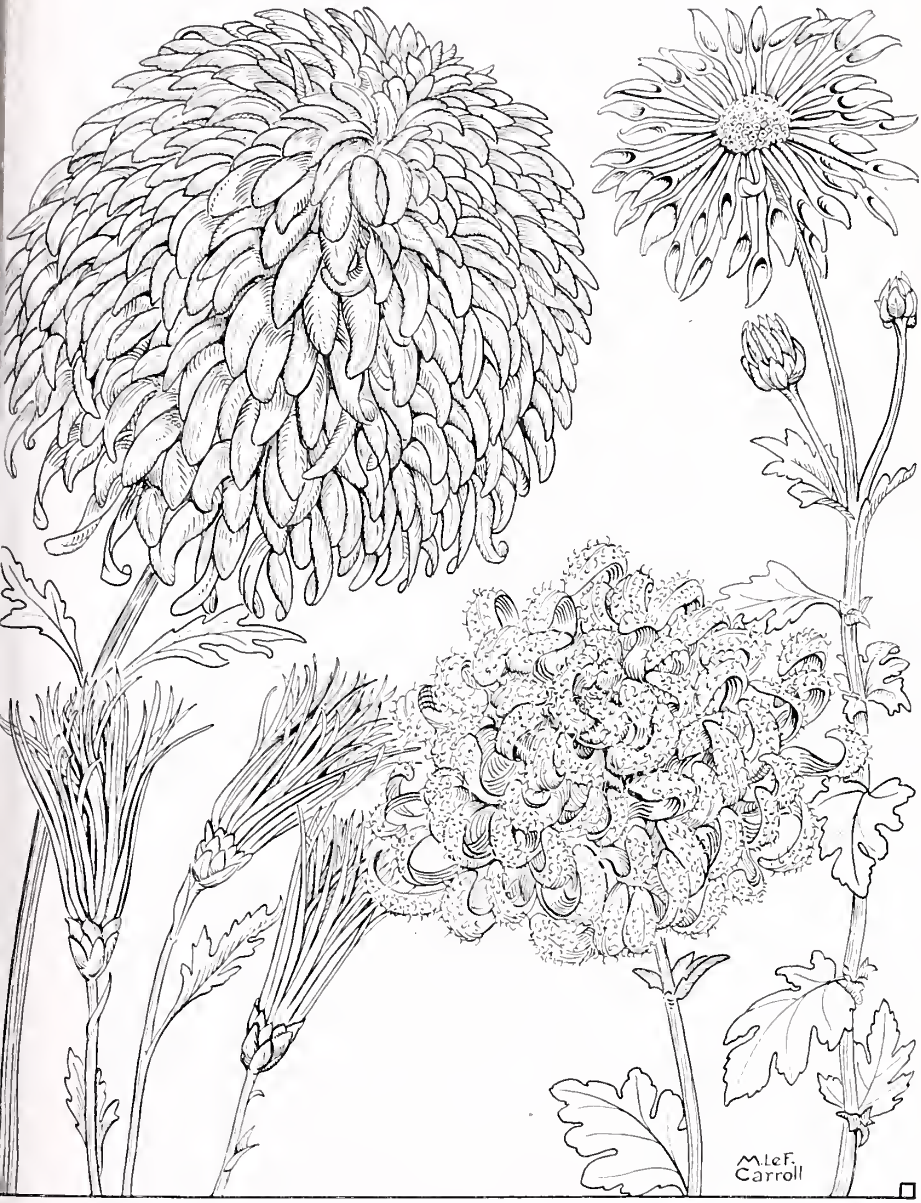
able; and, such is the adaptability of the chrysanthemum, the same variety used for making an enormous bush can be grown equally well, but reduced in size, in a 5 in. pot.

Some varieties have thinner and more flexible stems than others, making it possible to more easily train the plants in bizarre shapes as, for example, the model of the cathedral of Notre Dame made of growing chrysanthemums and the specimen in columnar form pictured on p. 144. The "cascade" types have this characteristic to perfection and are easily developed to give the effect of a cascade of flowers tumbling from the flower pot.

Chrysanthemums are what is known as "short day" plants. That is, with some exceptions, the flower buds are not formed until the day length is reduced to about 10 hours. Commercially, their flowering can be advanced by covering them with black cloth between the hours of 5 P.M. and 7 A.M. for about 3 weeks beginning around the middle of July. One variety thus treated bloomed on September 15th while the controls did not flower until October 20th. Contrariwise, increasing the length of day to 15 hours from about the middle of August to October may retard the normal time of flowering for as much as 4 or 5 weeks.

Their Origins

The garden and greenhouse chrysanthemums are supposed to have been derived from *C. morifolium,* a native of China with yellow disk florets and white rays; and *C. indicum,* native to China and Japan, with yellow ray flowers. Both species have small heads of flowers. The innumerable varieties originating from these two species are included by L. H. Bailey under the name *C. hortorum.* In recent years plant breeders in this country have been active in developing new types, especially among those suitable for outdoor culture, with the objective of obtaining varieties with early-blooming habit so that their flowers may be produced before they are subject to damage by frost; and greater winter hardiness. Towards these ends new species have been added to the *C. hortorum* complex. Alex. Cumming, of Bristol, Connecticut, was a pioneer in the use of *C. coreanum* as a parent and introduced many fine varieties as "Korean hybrids." Since then *C. arcticum,* the Arctic daisy, and *C. nipponicum* have been combined with Korean hybrids and varieties of *C. hortorum.* Some of the outstanding breeders of these types tell of their work in the pages which follow.



Types of Chrysanthemums

Large-flowered reflexed Spoon

Brush Hairy

GROWING LARGE CHRYSANTHEMUMS OUTDOORS

Ernest L. Scott

THE only reason that anyone who can raise good chrysanthemums of any type does not have large blooms is either that he does not want them or that he has not taken the pains to find how to produce them. True, only certain varieties will yield the large blooms but those that do will respond in the same manner to the same general practices that yield good results with any of the other types of chrysanthemums. Given good general culture any appropriate variety will yield a large bloom if properly "stopped" and disbudded. These then are the determining factors rather than some peculiar regime of fertilization, spraying or whatnot.

Stopping is practiced to accomplish one of three purposes: 1) to induce the formation of the desired number of branches at the desired time and in the desired place on the plant; 2) to control the final height of the plant; 3) to aid in controlling the time of formation of the flowering bud and so of the blooming date. Disbudding is practiced partially as a corollary to stopping in the control of the number and location of the branches and partially to determine the blooming buds.

In growing large blooms only one bud is permitted to develop on a stem or branch. The number of blooms on a plant will then be determined by the number of branches. The size of the bloom, other things being equal, will be determined by the number of blooms, i.e., branches.

Branching is induced by stopping. Sometime during June if the plant has not already been stopped by pinching, the growing tip will be converted into a flower bud, known as the "first crown" bud. This bud effectively *stops* elongation of the stem and starts the development of axillary buds. In case the plant has been pinched these buds will have been started by that act. These axillary buds, by whatever means they were induced to start, will develop into branches. The advantage of inducing their formation by pinching rather than waiting for the 1st crown bud is that they may be started earlier in the season and lower on the plant. When these buds have grown sufficiently so that they can be cleanly removed, all except the desired number of the strongest and best disposed are removed, together with the 1st crown bud and that portion of the stem above the uppermost branch which has been retained. The number of branches retained will depend on the results desired. For maximum size only one will be saved. Two will give excellent size and twice as many blooms. Two are considered by many commercial growers as the economic optimum. Where only one or two plants of a variety are grown it may seem best to allow even as many as six blooms to a plant. Though the blooms will be smaller they should have all of the perfection of form and color that disbudding gives.

When it is desired to control the height of the tall growing varieties these branches are again pinched after three or four leaves are fully developed. This will delay their elongation until new buds have developed and started to grow. The branches which result from this stoppage are all removed except one near the tip. This now becomes the leader. If not too late in the season this process may be repeated but in general no pinching should be done less than 100 days before the expected blooming date.

It is also well to remember that the

branches formed on hard wood are apt to be thin and to produce inferior blooms. Pinching, then, should not be so low that no soft wood will be left below the cut. If the branch will break square and clean when bent or if it can be cut cleanly by the thumb nail there will be plenty of soft wood left for satisfactory branching. This also is the reason that branches near the tip should be saved rather than those lower on the stem.

Pinching for the control of the blooming date depends upon the fact that the formation of the blooming bud is determined in part by the age of the branch which carries it. The exact age, however, varies greatly with the variety and other cultural conditions so that no general directions can be given. Success will depend upon the individual grower's experience.

During August or early September a second natural stoppage will be induced by the formation of the 2nd crown bud. In certain varieties this bud will yield the best bloom, in which case it is carefully retained and all of the resulting axillary branches are removed as early as is practical. When allowed to remain on the plant the branches which follow the 2nd crown bud develop a terminal cluster of flower buds. These terminal clusters form the sprays seen when the 'mums have not been disbudded and usually, except in the exhibitions and in certain of the commercials, a bud selected from such a cluster will yield the optimum bloom.

In this case the 2nd crown bud and all of the resulting branches, except one reserved to become the leader, are removed. After the terminal cluster has formed and opened up enough so that it can safely be done, all of the buds except the strongest one, usually the central one, are removed as are any axillary branches that may form. This will complete the work of stopping and disbudding for the season and nothing much remains to be done except to keep them free from aphis and to fasten them to their supports.

Plants trained to a single stem may be set as closely as 8 x 8 in.; when two stems are grown the spacing should be in-

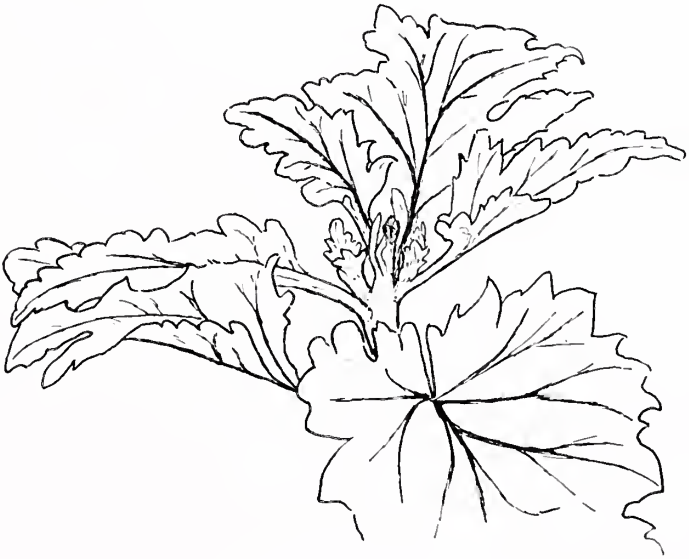


Fig. I. A CROWN BUD with the resulting axillary branches. The *first crown bud* should be removed together with all of the axillary buds except one. Usually the cut is made through the main stem below the uppermost axillary branch, leaving the second as the leader. The remaining axillary buds or branches are removed individually. The treatment for the *2nd crown bud* is the same when a *terminal bud* is to be saved for the bloom. When the 2nd crown bud is to be saved the axillary branches and buds are all removed severally but the crown bud itself is not disturbed.

Drawing by Author.

creased to 10 x 10 inches. Multiple stem disbuds with 6 or 8 branches may be set 15 inches apart in rows spaced 20 inches.

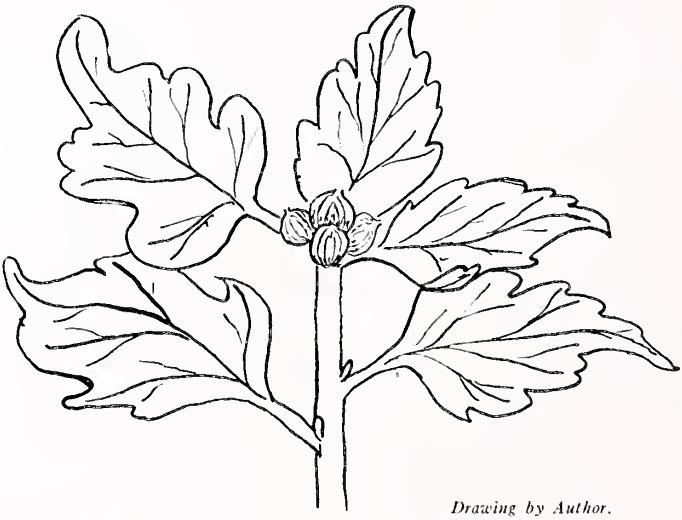
Disbudded chrysanthemums require adequate support because of the long stems and heavy blooms. These supports take almost as many forms as there are growers. However a single bamboo stake will be adequate in most cases provided each stem is tied individually at intervals of 12 to 15 inches.

The following list gives the names of some reliable varieties which we have grown. It is a good one to start with as all of them should be in full bloom by mid-October. The bud to take (retain) is also given.

Gold Lode, and Mrs. H. E. Kidder, bright yellow, 2nd Crown bud.
Smith's Early White, 2nd Crown bud. Silver Sheen, Terminal bud.
Bronze Lode and Indianola, both light bronze, 2nd Crown bud.
Lustre, Pink, 2nd Crown bud and Pink Chief, Terminal bud.

The following are favorites with us but bloom somewhat later, late October and early November:

Yellow Ambassador and Yellow Indianapolis, both Terminal buds.
Betsy Ross, white. 2nd Crown bud, Ambassador, white, Terminal bud, Indianapolis, white, Terminal bud.
Mrs. David Roy, red, 2nd Crown bud.
Cambria, bronze and Indianapolis, Bronze, both Terminal buds.
Indianapolis, Pink, Terminal Bud.



Drawing by Author.

FIG. 2. The TERMINAL CLUSTER soon after it appears. Note also terminal buds forming in the axils. The axillary buds and all but the strongest one, usually the central one, of the terminal cluster are to be removed. It is better to wait a few days until the stems have grown out a bit and the cluster has opened up, otherwise the bud may be injured.

GREENHOUSE CULTURE OF LARGE-FLOWERED CHRYSANTHEMUMS

George H. Gillies

CHRYSANTHEMUM HORTORUM, since its introduction into the U. S. A. in 1829 has become the mainstay of all growers who produce flowers in quantity from September to the end of January. Volumes have been written on the history of this most ancient flower; many more on its cultural requirements, and methods of training the varied forms of this Queen of the Autumn.

The hybridizers have kept pace with the changing modes of living by producing different types of this flower to suit the fashion of the day. Gone are the days of huge trained specimen plants carrying as many as six hundred flowers on a plant. These works of art belonged to the era when greenhouses were show houses and plants and flowers were admired but not touched. Gone also are the large exhibition blooms measuring thirty-six inches in circumference and grown on a stem six to eight feet tall, one flower to a plant. These belonged to the days of spacious living and large mansions and are now seldom seen except in chrysanthemum shows and in large display greenhouses.

Since these flowers represent the peak of cultural skill, a note on how they are obtained may not be amiss.

Perhaps the ease of culture of the chrysanthemum is responsible for the many abuses that this plant so often suffers in many greenhouses. The number one abuse is the lack of care bestowed on the stock plants from the time of the flowering period until propagation of new plants begins. During this period the plants are often stored under the greenhouse benches or on the greenhouse paths. While the chrysanthemum is a rugged plant and will survive this treatment, it does deserve a better fate. Definitely no exhibition plants or flowers were ever grown from the weak and drawn cuttings that are the result of this treatment. Perhaps for this reason more than any other the commercial grower has in the late years turned to the chrysanthemum specialist for his rooted cuttings. One such specialist turns out as many as twelve million rooted cuttings a year to supply growers with strong sturdy stock.

Propagation

Stock plants must be grown in a cool airy atmosphere to promote that strong healthy growth. Propagation of cuttings

Chrysanthemum Golden Ball, incurved petals

Chrysanthemum Lady Knox, reflexed petals

for exhibition flowers should be done in late February or early March. These should be inserted in a bench of clean, fine sand. Use only the growths from the base of the plants for cuttings. Stem cuttings should be avoided for these seldom grow satisfactorily and invariably form flower buds almost at once, resulting in a stunted growth. The use of root hormone powders has aided the propagator greatly since their introduction. A light dusting of these powders at the base of the cutting before insertion in sand will ensure a high percentage of rooted cuttings in from fourteen to twenty days. When rooted the cuttings are removed from the sand and potted into three inch pots in a soil mixture consisting of one-third loam, one-third leaf mold and one-third sand. This is a light mixture but one that the writer advocates as a gradual step from sand to soil which permits the plant to make a quick get-away. A heavy mixture at this stage is apt to check growth and it is important that at no stage of development should the growth be checked.

Culture

Plants in this light mixture should be well rooted and ready for repotting into six inch pots in three weeks to a month's time. The texture of the soil for this potting should be made heavier by increasing the percentage of loam. Any side shoots that develop during this period must be rubbed out as soon as visible, keeping the plant to a single stem. By the first week in June these plants should be well rooted and ready for their final potting into nine and ten inch pots. For this potting the soil should consist of two-thirds loam, the other third being a mixture of dry cow manure, sand and leaf mold with a liberal application of bone meal. In this final potting it is essential that the plants be firmly potted, the soil being rammed firmly around the sides of the pot. Firm potting promotes the strong short jointed growth that is desirable in this type of chrysanthemum.

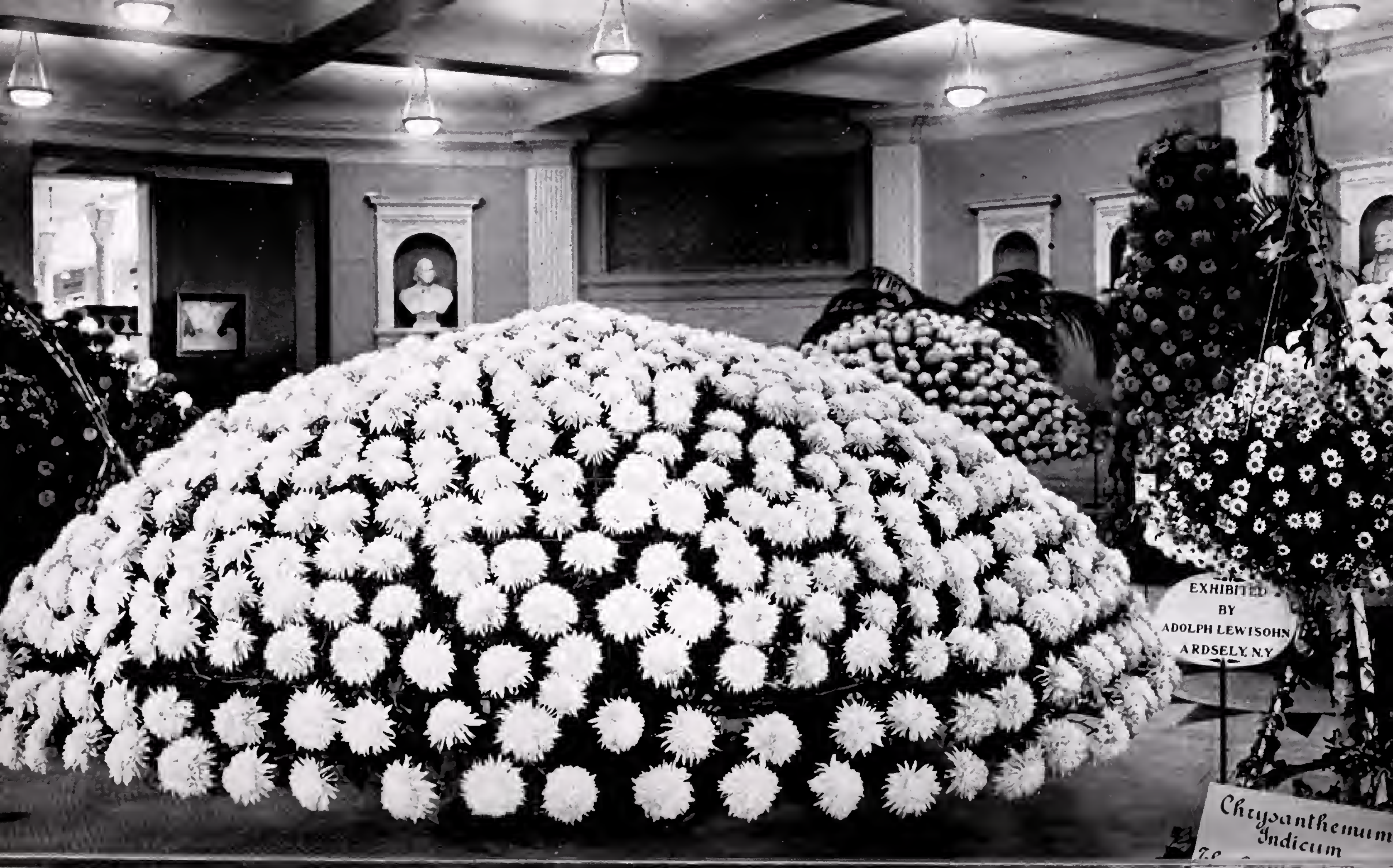
After potting, the plants should be staged in rows running lengthwise of the greenhouse. A strong stake is placed in each pot and the plant secured to it. The stakes should be six feet in length and they should be fastened at the top to an overhead wire. It is for this reason that it is suggested that the rows run lengthwise of the greenhouse.

In a month's time the plants will be rooted well enough to permit feeding with a quick acting fertilizer. Chrysanthemums are gross feeders and providing the plants are not fed while dry at the roots, once a week is not too often to fertilize at this stage. Since each plant has an individual pot they must be watered as individuals and no indiscriminate

---

Specimen bush, Well's Late Pink →

Courtesy Horticultural Society of New York. Maugans photo.


EXHIBITED
BY
ADOLPH LEWISOHN
ARDSELY, N.Y
Chrysanthemum
Indicum

splashing should be done. When a grower arrives at the knowledge of when and how much to water, he or she has mastered one of the arts and is worthy of the name grower. During the hot summer months chrysanthemums relish a light spraying two or three times a day, but the last spraying should be done in time to enable the foliage to dry before evening sets in.

Taking the Bud

The modern exhibition varieties will, if propagated at the time mentioned, show the crown bud in early to mid August. (See p. 153.) It is on this bud that the best blooms are obtained. The only stopping necessary is when plants show signs of forming the bud in July. This being too early, the bud must be eliminated and the second crown bud taken when it appears in mid August. This is a compromise measure, but in the writer's opinion the question of time in securing bud is more important than type of bud. N longer is it necessary to keep time char on varieties that need growth pinching July in order to throw buds at the corre time.

The term, "taking a bud" is somewh misleading. Actually it means to lea the crown bud and rub out all side bu which cluster around the center or crow bud. This disbudding should be done soon as the buds are visible. This oper tion is easily done in early morning late evening when the growth is britt and the side buds may be removed wit less chance of damage to the crown bu The development of this flower bud slow until aided by the cooler weather late September and October.

Feeding at this time must not be over done or crippled flowers may result, an all feeding should stop as soon as colo shows in the bud. All spraying of th plants should cease at this time also, an any insect pests be kept down by dustin or fumigation. Maintain a dry airy at

Chrysanthemum display at the Garden. Branched and disbudded plants in foreground, single-stem large-flowered plants in rear

THIS COLLECTION OF CHRYSANTHEMUMS WAS GIVEN BY TOTTY'S - MADISON N. J.

mosphere in the house as the blooms develop. Watering operations should be done before mid afternoon, allowing the house to dry before night, for damp is fatal to the unfolding petals. Before the flower unfolds see that all stakes reach to the underside of the calyx and no higher. This permits the long petals to unfold and hang down unobstructed, yet supports the flower to the utmost.

Pests

While a vigorous grower the chrysanthemum has its share of diseases and insect pests. The most destructive and a comparative new-comer is the chrysanthemum midge. Since this pest operates under the surface of the leaf and if uncontrolled stunts the plant, it calls for a special schedule of spraying to eliminate. A weekly spraying with Loro has proved an efficient killer. The use of sodium selenate applied to the soil has proven successful in eradicating the midge and is an example of the scientist coming to the aid of the grower. Aphis and red spider, two old enemies may be controlled by the spraying advocated during the growing season and by dusting and fumigation during the later stages of development. Mildew which often appears in the cool damp weather of early October may be kept in check by dusting with sulfur.

Since this article deals with the large exhibition chrysanthemum this cultural outline confines itself to growing under ideal conditions one exhibition flower to a plant. War conditions have taught all growers how to cut corners and save labor in their growing operations for quantity production at low cost. Growing blooms for exhibition calls for more care and attention to detail than does mass production and is definitely a work for the specialist.

* * *

Bed of seedling chrysanthemums

It is a pleasure for Plants & Gardens to acknowledge the courtesy of Charles H. Totty Company, Inc., Madison, N. J., which enables us to present the following pages of chrysanthemums in color.

CLASSIFICATION OF CHRYSANTHEMUMS

Henry K. Svenson

THE name means "golden flower," and it was originally applied to the plants of the eastern Mediterranean region which we now call the Garland Chrysanthemum (*Chrysanthemum coronarium*). It was in cultivation as early as the 16th century, and decorations of this plant are found in early Egyptian tombs. The Common Chrysanthemum (*C. indicum*) was also known in Europe at an early time from decorations on oriental art objects, but plants were first brought to Europe in 1676, arriving in Holland from East Asia. It belongs to the large Composite family, which includes the asters, goldenrods, and sunflowers.

The genus *Chrysanthemum* contains about 150 species, chiefly native to the area extending from the Mediterranean Sea to Persia. A group of about 20 species is known from the Himalayas to China and Japan.

Very early the genus was divided into white-flowered species (*Leucanthemum*) of which our common field-daisy is an example, and the yellow-flowered species.

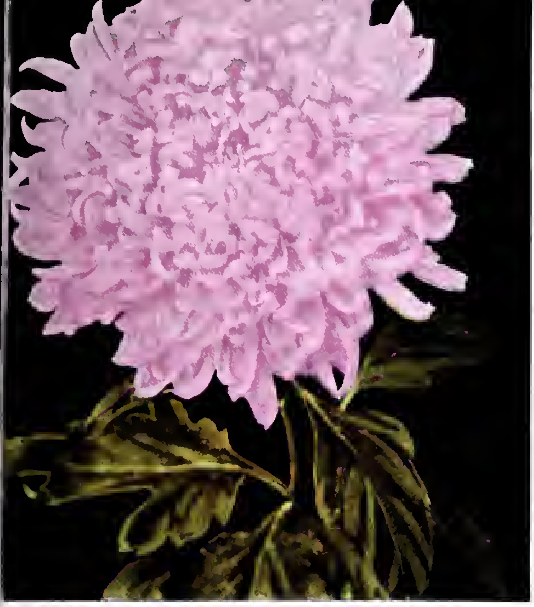
The Chrysanthemums may be classified either from a horticultural or botanical viewpoint. Horticulturists separate them into the following series:

1. Annual Chrysanthemums (such as *C. coronarium*).
2. Feverfews. Forms of *C. Parthenium*.
3. Pyrethrums. *C. coccineum* (flowers from red to lilac or white).
4. Marguerites. *C. frutescens*.
5. Perennial border Chrysanthemums. *C. achilleaefolium, C. arcticum*.
6. Common Chrysanthemum. *C. morifolium* (*C. indicum*).

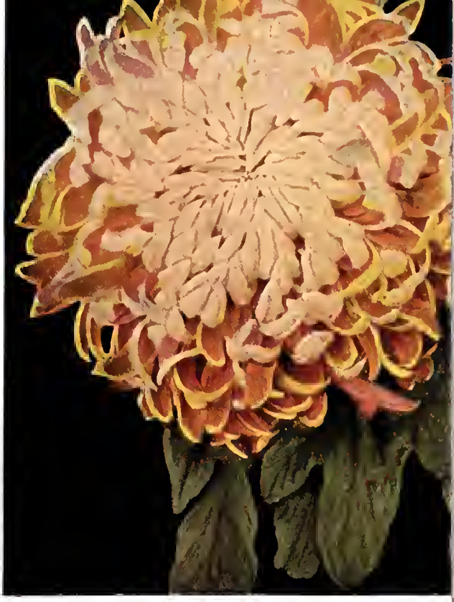
Botanists classify them according to the color of flowers, shape of the seed, and whether ray flowers are present or not. The groups are maintained as distinct genera by some botanists.

1. Pinardia. All yellow-flowered, including *C. coronarium, C. viscosum, C. segetum* (Corn Marigold).
2. Ismelia. *C. carinatum* (Tricolor Chrysanthemum), an annual with dark purple disc.
3. Myconia. *C. Myconis* (*Pyrethrum Myconis*). A yellow-flowered species of southern Europe.
4. Argyranthemum. (The name means "silver flower.") *C. frutescens*.
5. Pyrethrum. Includes white-weed or daisy (*C. Leucanthemum*), *C. arcticum, C. corymbosum, C. cinerariifolium* (Dalmatian insect powder), *C. morifolium*.
6. Tanacetum. *C. Balsamita* (Costmary), *C. macrophyllum* (Tansy Chrysanthemum) and *C. Tanacetum* (Tansy).

The varied forms of the Florist's Chrysanthemum (*C. morifolium*) have been developed through centuries of selective cultivation in the Orient.

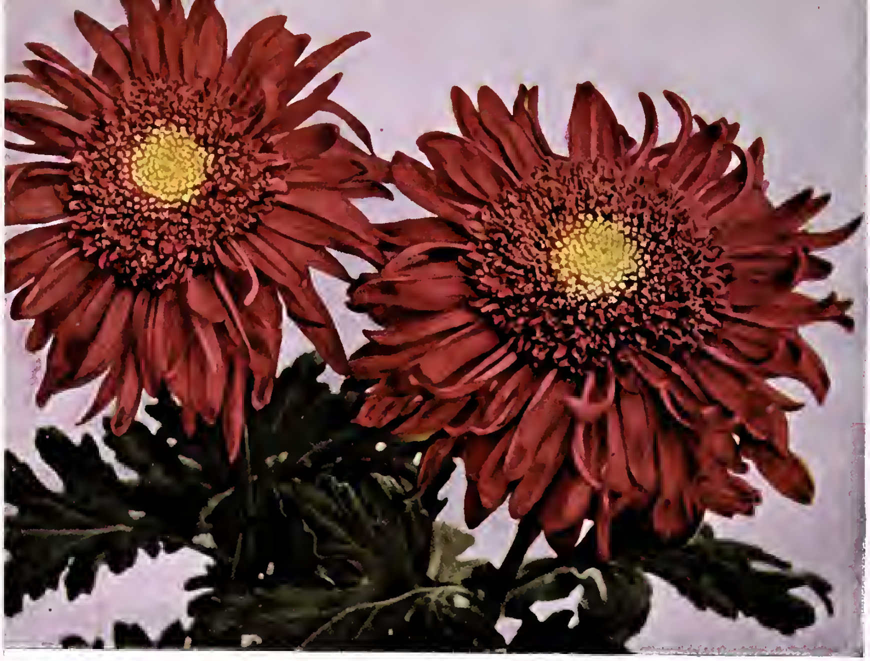


Commercial Type Chrysanthemum



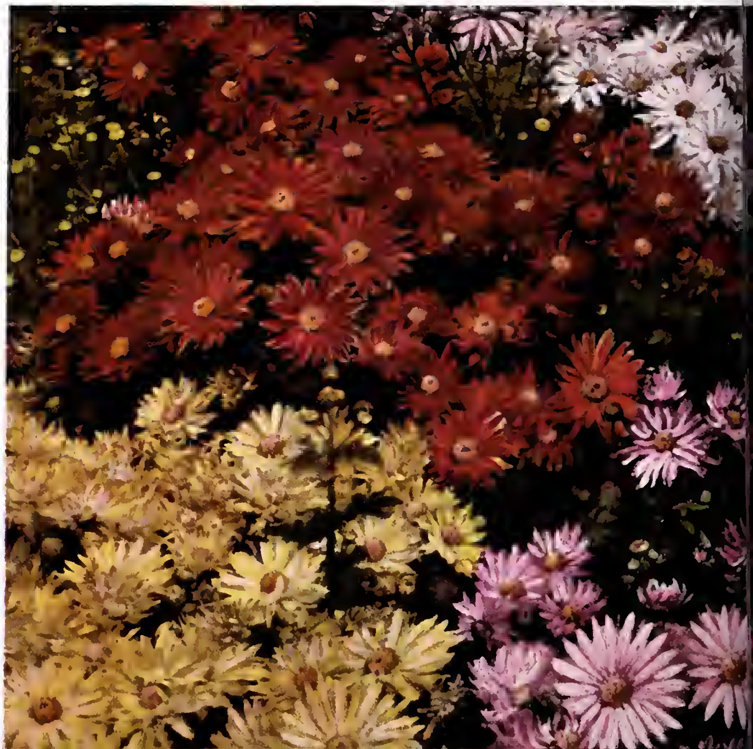
Commercial 'Mum

Meta J. Bergen



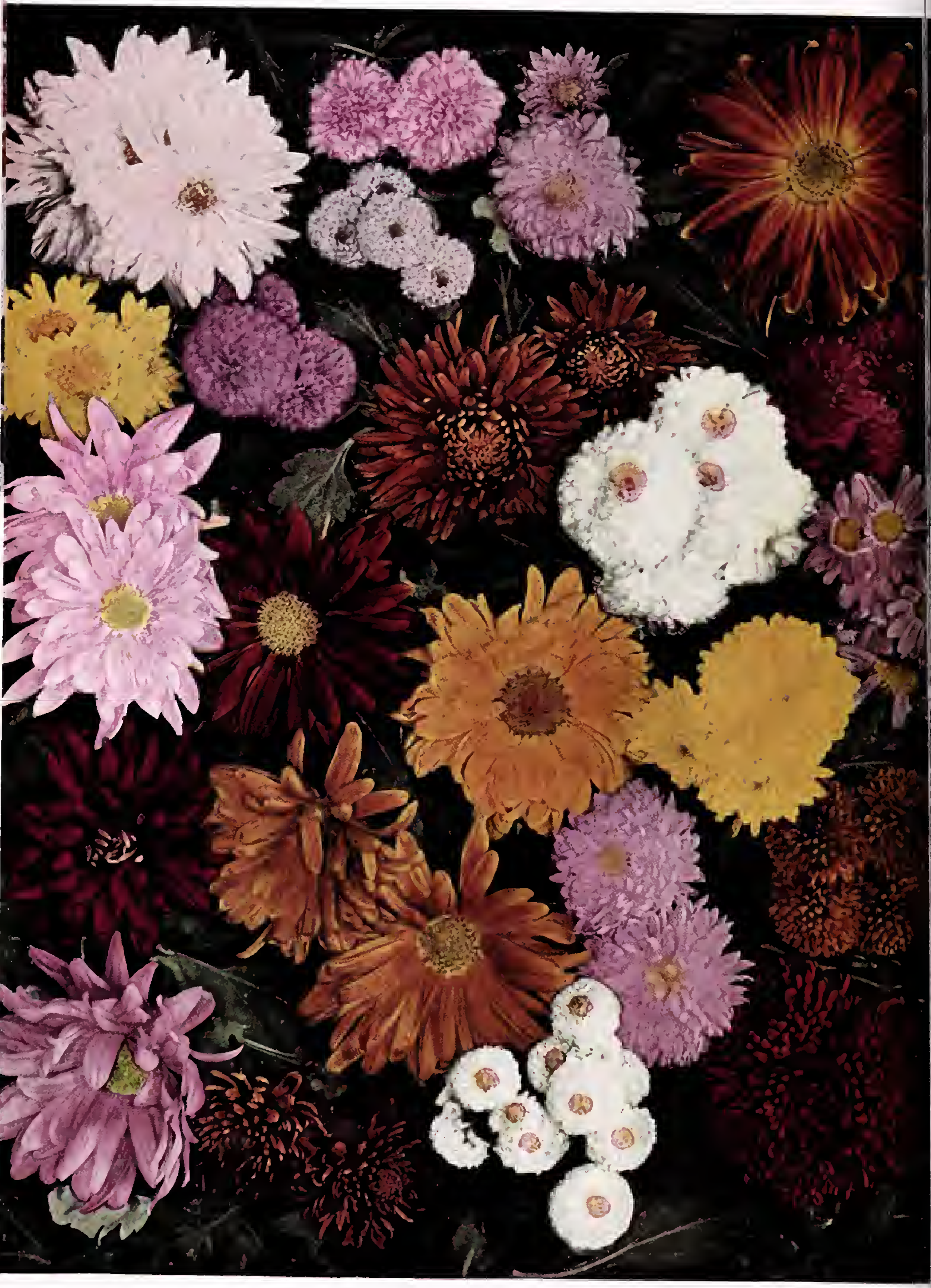
The Titan

Hardy



Unique

aisies



Types of Hardy Chrysanthemums

GROWING HARDY CHRYSANTHEMUMS

Henry E. Downer

In growing chrysanthemums outdoors the site has much to do with their well-being. They seem to thrive best with full exposure to sunshine, but do not object to a short period of shade during the day. Good air circulation is essential to sturdy healthy growth, although a wind-swept place is not favorable. In a low-lying situation damage from early frosts will be the most severe. Very important is the matter of good drainage, for the chrysanthemum objects to standing with wet feet and soon vacates such a spot. Poor drainage, rather than low temperatures in a particular garden, will more likely determine whether many varieties may be grown as perennials or annuals.

Chrysanthemums are not especially sensitive to acidity and alkalinity, so long as it is not extreme either way, but they do appreciate a free-working soil that has been stirred and enriched to a depth of 12 inches or more. Soil of a heavy retentive nature may be made to their liking by the admixture of ashes or other good porous material; and be still further improved by a sprinkling of hydrated lime previous to planting. This plant is a hearty feeder, and likes to find some "fat" in the soil in the form of well rotted manure or other good organic matter, especially if the soil is on the sandy side. Bonemeal is a good food supplement to apply in early spring, and later on when growth is nicely under way, a sprinkling of a complete commercial fertilizer will keep them going in fine style. The foundation for best results however, is a healthy plant set in well prepared soil, and not dependence on something smelly out of a bag.

While some varieties will continue to give good results when the clumps are left undisturbed for more than one year, it is a good rule to propagate young plants annually, and may mean the difference between just living and thriving. With named varieties it has been customary to lift "stock" plants soon after flowering of those known to be uncertain as to hardiness, set them in flats of sandy soil and winter them under the protection of a cold-frame. In February these flats may be transferred to a cool greenhouse, and in a short time new growth is available for a batch of cuttings. These are made about 3 inches long, placed in moist sand, pricked off in flats of good soil when rooted, where they will make nice plants to set out in early May after being hardened off for a few days. In gardens that have no glass to work with, the old clumps can be dug in spring when new growth is evident, and strong-rooted single pieces pulled off for transplanting. It is not advisable to divide and transplant outdoors in the fall, as most likely there would not be anything alive in spring.

It is always interesting to grow chrysanthemums from seed collected from a good source. For mass display and abundance of flowers for cutting it is well worth while, and among the profusion of single and double flowers there is always the chance of a "prize" worth perpetuating by cuttings. Seeds may be sown from mid-February to mid-March under glass, and in about six weeks time the seedlings will be ready to transplant into flats in which they may be carried along until planting out time in May. In the Brooklyn Botanic Garden a display of seedlings has been a good fall feature for many years. More recently displays of seedlings have been featured in parks of New York and other cities (also in certain college and community gardens) through the interest and generosity of Mrs. Albert D. Lasker in donating seeds of a hardy strain developed in Illinois. A colorful early-flowering strain known as September Jewels is offered by some seedsmen.

It is desirable to plant as early as conditions will permit, so that the plants will have a chance to be well established by the time hot dry weather is likely to set in. However, pot-grown stock can be set out through June and will soon get going if firmly planted and watered well as may be needed. The matter of summer watering is something not to be undertaken lightly. It is a good plan to defer it as long as possible, then give a thorough soaking. Avoid wetting the foliage, as any possible good may be more than offset by encouragement to diseases. During the early part of the season frequent shallow cultivation is beneficial by maintaining a loose surface and taking care of the weeds.

When the young plants are about 6 inches high the growing point should be pinched out with the finger and thumb to induce low branching. With most varieties this should be repeated well into July whenever new shoots get to be about 6 inches or so long. The cushion type does not need more than the initial pinch. If a plant gets lanky by any chance, do not cut back to hard wood or it may be crippled, but stake it instead. Properly handled most varieties will not need staking, but, if necessary, attend to it before the stems topple and do it in such a way as to give effective but inconspicuous support. A good job can be done with twiggy brush. Taking into account differences in habit and size, a spacing of 15 to 24 inches between plants should be allowed, with 24 to 36 inches between rows when grown in that manner. It does not pay to overcrowd.

Chrysanthemums are good-natured about being transplanted from a reserve plot to fill gaps in the flower border in late summer, even up to the point of showing color. A showery time is ideal for the moving, but a good watering in advance to ensure a ball of soil with the roots, and a thorough soaking after planting will set them up in good style. To give protection against possible diseases it would not be amiss to spray with a copper preparation once or twice in early summer. Aphids should be watched for and dealt with on sight by applying a good contact insecticide. Sometimes their appearance is delayed until flowering time.

Winter protection is often given too soon and too much applied so that the plants are smothered to death with good intentions. It is well to delay it until the ground is frozen, and whatever is used should be of a light littery nature. The stems should be cut back to about 4 inches, and if free of disease may be laid over the crowns to hold loose dry leaves. Pine needles are excellent cover, also evergreen sprays. Uncover gradually in spring, and do not be unduly excited by the first warm days in March.

In the catalogs of hardly plant growers outstanding varieties of the various types are listed and described. Not all do equally well in every section, but there are so many good ones that no time should be wasted on a poor doer. The trend is to early flowering as well as hardiness. The cushion type starts in July, which is early enough. The colors now include pink, white, yellow, red, and bronze shades. The lovely Koreans come along in September and into October, with many single and double varieties to pick from. The hardy *Chrysanthemum arcticum* has been used to produce a charming and hardy race of hybrids—first represented by Astrid and now with others of equal merit. Barbara Cumming, one of the older decoratives, is still worth a place for its profusion of yellow to bronzy flowers, which start early and stay late. The newer Mme. Chiang Kai-shek seems to be endowed with all the good qualities to ensure popularity for a long time. Amongst pompons Judith Anderson is my ideal, bearing its profusion of bright yellow buttons after dry or wet summers right up to hard frost, and always in place in spring.

* * *

WINTER HARDINESS IN CHRYSANTHEMUMS

W. D. Holley

Pictures from Photo-Visual Service of the University of New Hampshire

PERFECT hardiness in chrysanthemums is something many breeders have thought within their grasp, yet these same hardy chrysanthemums, when tested in a different locality, have winter-killed. Why are chrysanthemums hardy in one section and not hardy in another locality which apparently has a milder climate? Chrysanthemums that are absolutely hardy at Saint Paul, Minnesota or Cheyenne, Wyoming, may not be as hardy at Durham, New Hampshire.

The reason for this difference in hardiness is in the depth of snow cover during extreme winter temperatures and in the moisture content of the soil. During a prolonged period of sub-zero weather the ground may freeze only a few inches if there is a blanket of snow over the soil. When such slight freezing occurs, the temperature of the crown and roots of plants does not reach extreme low temperatures. In fact, soil temperatures may stay close to the temperature of ice or 32° F. However, without snow cover, the soil may freeze to a depth of 18 inches or more while the temperature of the crown of plants near the soil surface may go almost as low as that of the air. Probably +10° F. or temperatures slightly higher are sufficient to kill the roots of most chrysanthemums. Chrysanthemums and other perennials also tend to kill more easily in extremely dry soils.

Winters at Durham are not usually severe, although sub-zero temperatures occur every year. We usually have a snow cover during the coldest weather but this is not dependable. During the winter of 1942–43 several days of −20° to −35° F., coming with a good snow cover, caused little or no injury to chrysanthemums. The following winter of 1943–44 brought us four consecutive days of temperatures from 0° to −7° F. with no snow cover. Many perennials including some varieties of bearded and Japanese iris, strawberries and parsnips were killed during this period.

Table 1 shows the extent of injury on the varieties of chrysanthemums on trial at that time. This group had been reduced in the fall of 1943 to just those varieties most desirable for this section. All varieties blooming later than mid-October were eliminated since we can ex-

TABLE 1. WINTER INJURY ON UNPROTECTED CHRYSANTHEMUMS AT DURHAM, NEW HAMPSHIRE—1943–44

No Injury	Slight	Severe	Killed
Manadnock	Absaroka	Chippewa	Bronze Beauty
Merrimack	Algonquin	*Dean Kay	Bronze Cushion
Nashua	Autumn Lights	Dean Ladd	Cameo Queen
Sunapee	Cocheco	Duluth	Golden Wonder
	Exeter	Early Bronze	Greylock
	Seminole	Harmony	My Lady
	Welcome	Sunred	Ogallala
			Osage
			Red Gold
			Redsa
			Red Wing

* See p. 172.

Exeter, is one of the finest New Hampshire varieties for all round garden use

pect temperatures of 22° to 25° F. at about that time each year.

The four chrysanthemum varieties not injured during the winter of 1943–44 are seedlings developed here at the University of New Hampshire. They are among the hardiest and best of some 25 selections made in 1942 and will be available from the trade in the spring of 1947. Manadnock is dwarf, early blooming, with bronzy red button type flowers. Merrimack grows to approximately three feet tall in good soil and resembles its parent Autumn Lights except that its flowers are more of an orange color. It is excellent for mass effect and it is early. Nashua, a bronze blooming September 1, and Sunapee, a gold blooming September 15, are best for cut flower purposes. In good soil Exeter, which was injured slightly, grows about 15 inches tall and spreads at least two feet. It blooms September 20 and later with full double, reflex, yellow flowers two and one-half inches across.

Most of the University of Minnesota chrysanthemums are hardy enough to be satisfactory in New Hampshire. The University of Chicago mums have not been through a test winter but those earlier blooming varieties are most desirable in New England gardens.

Of the strains of chrysanthemums which are grown from seed, rubellum hybrids have been very satisfactory in this climate. Although they bloom in October and later they are sufficiently frost hardy to be of value in New Hampshire. Korean hybrids have bloomed too late to be of value in our gardens.

Among others we still recommend many of the early cushion-type chrysanmums for garden use in New Hampshire and similar climates. Since these varieties bloom early and long, we feel that they are well worth the price paid for them, even if they are killed after one, two, or three years. When planted in a well drained soil they will come through most winters without injury.

Hardy chrysanthemum Cocheco—a new variety given an Award of Merit by the Massachusetts Horticultural Society

HYBRID KOREAN CHRYSANTHEMUMS —THEIR HISTORY

Alex. Cumming

IN the chronology of the chrysanthemum, which dates back to and beyond the days of Confucius, the Hybrid Korean type is as yet in its infancy for the first Hybrid Korean type chrysanthemums were introduced to the gardens of America by the Bristol Nurseries in 1933. It would be interesting to know just how many descendants of this type have found their way into gardens here and abroad in the short thirteen years intervening. It might also serve as a startling indication of the almost universal interest in the garden chrysanthemum. Thinking along these lines it occurred to me that a more or less intimate account of the development of the Hybrid Korean type might prove of some interest to the chrysanthemum enthusiast.

Between the years 1928 and 1933 some sixteen varieties of the pre-Korean or hortorum type had been developed and introduced from Bristol. All of these I considered improvements in some particular respect. The aim was towards increased hardiness and a better growing plant, but the process was tedious and no definite advance was accomplished.

I decided that the addition of entirely new blood lines would be the best answer. *C. coreanum* appeared the most likely of the various species available. It was extremely hardy, its growing habit vigorous and robust. We went to work on this parent rather extensively, knowing that the path ahead involved a lot of elimination before any worth while results could be expected.

In the autumn of 1929 many crosses were made in which *C. coreanum* was used as the mother parent; in others as the pollen or male parent. From among these an original cross between Ruth Hatton and *C. coreanum* produced some thirty seedlings in that year. One of these proved of particular value. Our records described it as "White to light pink. Grow 25 for observation, and self (meaning inbreed), this might be a hybrid." This it later proved to be. It was numbered 64–29, doubtless the first actual Korean Hybrid of record.

The following year, 1930, a considerable quantity of seedlings from this cross as well as from a group of which *C. coreanum* was the seed parent were grown. Altogether 33 seedlings were numbered and recorded this season. Not one of the lot, however, could be considered of any garden value, the majority being of the single type, more or less malformed in the petals or blossom, but nearly all showed definite traces of the *coreanum* parent, which in itself was exciting.

The group on the whole was so distinct from the regular type of seedling that key initials were added—C.K. meaning to us *Chrysanthemum* × *coreanum*; K.C., *coreanum* × any chrysanthemum of the older *hortorum* type. Thus the descendants from these two original combinations have since been distinguished in our records, although other initials have been added to the line-up, denoting a further ramification of breeding lines.

From a breeding standpoint the seedlings in this year 1930 looked definitely promising, so a considerable amount of inter-breeding and selfing was done on controlled plants under glass. Other types such as pompons and the full doubles were added to the parent group.

The fall of 1931 proved exciting indeed. Eighty seedlings altogether were selected and duly recorded. The business of intercrossing and selfing continued on a larger scale. Remember we were still

Korean hybrid chrysanthemums. Class from Kings County Hospital enrolled in Course for Student Nurses working with something entirely new and strange to us. In this generation reversion to a primitive type appeared—heavy-set plants with glossy leaves—reminding one of *C. nipponicum* rather than the typical chrysanthemum plant. On the other hand more perfect flowers, most of them of the single type, were numerous. Tints and colors entirely new to the chrysanthemum and thrilling to behold were appearing each day. Selections were also made this season of a number of seedlings showing a tendency towards doubleness, some of which were selfed, many interbred.

From among the single types, however, a number were selected showing sufficient merit to warrant introduction. Production of these got under way. Mercury, Daphne, Ceres, Diana and Country Girl are survivors of these 1931 selections. They were introduced in 1934 among others of the older *hortorum* type.

From the 1932 selections, Louise Schling, Innocence, Mars, Aphrodite and Apollo, the latter the result of a cross between Early Bronze Pompon × *coreanum* seedling. These were introduced in 1934 and 1935.

The first selections of full double hybrids were made in 1933, Indian Summer and Romany to be introduced in 1936 followed by King Midas and The Moor in 1937. Then came the deluge. New Korean Hybrids began to appear from many sources here and abroad, and each season their number increases.

So far I have stressed the development of the Korean Hybrid type. During the period mentioned, however, we were using a number of other parent types including *C. arcticum*, from which Autumn Light was introduced in 1940. *C. nipponicum* after what seemed like endless generations of interbreeding produced a desirable type, some of the hybrids of which differed in color tints as well as in having better textured blossoms and foliage, and stems somewhat more woody and willow-like. Intercrossing of the above mentioned hybrids plus some others not mentioned has provided a wealth of material for further breeding.

In the course of this chrysanthemum development, a dwarf type was evolved; tiny plants not over six inches in height, lovely little things in full flower by late August. Two definite faults, however, prevailed in this type. First, the plants were difficult to propagate; second, the root systems were too shallow and light to survive a cold winter and resist dry summer conditions without a great deal of attention. By further selection and the addition of some new blood this type will eventually prove of garden value. There is a definite need for rock garden color from August on. The dwarf chrysanthemum would fill in here nicely.

Since fall is the natural chrysanthemum season, preference should be given to kinds that flower in that season. Nevertheless there is a constant demand for summer-flowering chrysanthemums. The commercial grower is, perhaps, largely responsible for this for he brings chrysanthemums into flower a good two months before their normal season through special culture and a demand has developed for these artificially produced early 'mums. Before long we shall see a new summer-flowering type of garden chrysanthemum. I am not thinking of the azalea-like or cushion-type 'mum which, as we know, may flower as early as July. I cannot feel that these are true summer-blooming types but simply earlier flowering adaptions of the fall chrysanthemum. The true summer-flowering type must develop from a parent which is also summer-seeding and this is coming about. When it does, the progeny will be a chrysanthemum which will not only flower continually from mid-July through summer but must produce flowers of good color, good keeping quality in all respects, not the abortive flowers that are now produced in the heat of summer. The "cut and come again" tendency already in the chrysanthemum can be developed to advantage in the summer-flowering 'mum.

CHRYSANTHEMUM ARCTICUM HYBRIDS

V. R. De Petris

BACK in the early part of the year 1930 there began a revival of interest in hardy chrysanthemums. This was to a great extent directly attributed to the introduction of the Korean hybrids by the noted hybridizer, Alex. Cumming. Until this event the vast majority of the meagre assortment of garden "hardies" were importations from abroad.

There is no implication made as to the merits of imported varieties as against our domestic originations. However, what is very pertinent is that chrysanthemums which have been given the badge of approval in certain regions of our globe will not necessarily prove satisfactory in others. This is particularly true of the chrysanthemum which is very sensitive both to heat and light, for the former affects both color and substance while the latter controls the bud inception period and therefore the time of flowering. Garden chrysanthemums imported from Europe and England although quite outstanding in these regions usually developed serious faults when grown in America. We can readily see the reasons for this. The milder climate and the longer daylight periods in the various European regions were well suited for each variety which became so outstanding there. Yet when these same varieties were grown under the changed climatic conditions of our American gardens the final results were generally disappointing.

Four single De Petris hybrids

A. B. Morse photo.

The introduction of interspecies hybrids opened the way for vigorous types and novel color blends, something which the inbreeding of *hortorum* varieties did not possess. Even though all of the Korean hybrids may not have been hardy they generally did possess the more vigorous habit which we look for in garden chrysanthemums.

The writer's experience with chrysanthemums has been confined almost entirely to that of the commercial greenhouse types. In order to bring about the infusion of greater vigor, and disease resistance as well as new color blends, crosses were made not only with *Chrysanthemum coreanum* but also with the sturdy *C. arcticum.* Later *C. nipponicum* was used as a parent.

Because *Chrysanthemum arcticum* produced so many seedlings with excellent foliage, vigorous growth and numerous strong stems, they were tried for outdoor varieties and a smaller percentage were bred further for greenhouse types. Since *Chrysanthemum arcticum* is a very primitive species the inherited traits showed a very strong dominance over the other more refined varieties. Countless hybrids had to be raised and many generations had to be produced before these wild traits became recessive to the desired characters sought after in both greenhouse and garden types. Moreover all seedlings of the *Chrysanthemum arcticum* proved to be almost uniformly late in blooming, varying in this respect from October 10th to October 20th in the latitude of Detroit.

On several occasions the temptation was strong for discontinuing what appeared to be a hopeless task. It seemed a pity to see beautiful plants, that thrived and grew in spite of the severe Michigan winters, considered useless for further breeding, yet there seemed to be every reason to believe that the trial of the wild arcticum dominance should end sometime soon. Consequently more crosses were made between these lush hybrids and numerous other parents which might impart better flower form, color and substance. These crosses included strains of the better greenhouse types plus improved Korean hybrids and some of the *Chrysanthemum nipponicum* strains.

The first acceptable results of the arcticum hybrids came in the varieties named Arctic Queen and Coral Sea. The former resulted from crosses which, among others, included seedlings from Valencia, one of my best greenhouse single duplex varieties, and a Korean hybrid. This variety possesses the typical arcticum foliage and habit while its flower compares well with the indoor commercial singles. Coral Sea is an arcticum seedling of the "cushion type." It is dwarf and spreading in habit, with medium small, leathery foliage; and semi-double in form. These varieties are just as hardy as the original arcticum parent and equally as easy to grow. Moreover they both possess a free-flowering habit that has overcome the tendency of the arcticum parent of producing blind vegetative shoots from newly planted young stock. Their colors are golden bronze and buff bronze respectively. Other true arcticum hybrids disseminated three years ago included Winsome, Pollyanna, and Dubonnet. These three varieties were single daisy types.

The further development of the arcticum hybrids was in the direction of obtaining fully double decorative types. Thus far, several seedlings have been produced. The first of these double arcticum hybrids to be disseminated was Allegro. This variety has a very novel and appealing color which is quite difficult to describe. One could call it shrimp pink with a coppery buff suffusion. It is fully double in form and of the decorative type. The parentage of Allegro is an involved mixture of arcticum seedlings crossed with commercial greenhouse varieties and the nipponicum hybrids. In growth it closely resembles its arcticum parents but is much taller, attaining a height of two and a half feet or more. It is superhardy and makes excellent cut flower material even though no staking is required. When disbudded Allegro produces beautiful blooms more than three inches across.

A. B. Morse photo.

Double-flowered De Petris hybrids

Looking into the future we must not assume that we have come to the end of the trail in the development of arcticum hybrids. The traits which we are seeking to preserve in this strain of garden chrysanthemums are those of extreme hardiness, disease resistant foliage and sturdy erect habit of growth. The new traits which we are attempting to breed into this strain are better substance, earlier flowering and fully double form. This can be accomplished only by cross breeding with sturdy-growing varieties which are more or less homozygous to these respective traits. In doing so one must be prepared to face the disappointing fact that many of the resulting seedlings will appear as worthless and even inferior to original parents. Yet knowing the genetic law of recessives we must feel certain that some of these apparently worthless hybrids are potentially the prototypes of much coveted new varieties for which we are striving. And so the breeder is called upon to bring forth his keen and observing skill to select the parents of a future improved variety from an apparently motley collection of worthless plants. Failure to do this would necessitate growing countless hybrids which would make plant breeding both prohibitive financially and impractical.

In further developing arcticum hybrids for outdoor gardens one objective has been the production of early-flowering varieties. Regardless of all that may be said for October-flowering garden chrysanthemums I still am firmly convinced that the great majority of gardeners prefer to enjoy their flowers in the frost-free period of September when gardens still look green and the outdoors is still an appealing and inviting place to stroll. Particularly is this so since the acceptable September-blooming chrysanthemums will still be gay with color well into October. Yet another factor which is becoming more apparent is that we are eventually going to have two distinct types of garden chrysanthemums. One of these will be dwarf and spreading with myriads of colorful blooms which will be planted strictly for garden effect. The other type will be taller with larger blooms which can be used for garden decoration as well as for cutting. Both these types must be of sturdy and vigorous habit. The amateur has no time or patience with temperamental weaklings no matter how beautiful might be their blooms. However, in this latter class the superiority of the individual bloom is emphasized over the dwarf border type. Although an era of large exhibition blooms is neither feasible nor desirable there will be a happy compromise to the medium era large blooms which possess both good color and substance.

Though these remarks may seem visionary we must not forget that the development of hardy garden chrysanthemums is just beginning. Many pleasant surprises lie ahead. The dawn of a rosy future is all the more promising because the framework of this pattern has begun with sound basis of interbreeding with sturdy and desirable species. Thus the pitfalls resulting from inbreeding of weak and disease-susceptible varieties have been obviated. The future holds many pleasant possibilities not only for the arcticum hybrids but for the other strains which are contributing toward making the chrysanthemum not merely the queen of the autumn but the cherished gem of the waning summer days.

* * *

A panel in the chrysanthemum display in the Horticultural Section of the Garden is devoted to De Petris hybrids this year, through the courtesy of Max Schling, Inc., N. Y. City. [Ed.]

PRODUCING NEW CHRYSANTHEMUM VARIETIES

H. Roy Mosnat

THE chrysanthemum for many years has been recognized as a fine garden flower, but with the defects of not being reliably hardy, and blooming much too late in many sections. So, not being satisfied, I decided to do something about it.

The old-fashioned cushion 'mum while the hardiest kind available is not reliably hardy and furthermore is too low and not good for cutting. It blooms fairly early, but is only semi-double. However, it has a bushy form, which is a desirable factor, and remains in bloom a long time.

Could the cushion type be crossed with taller varieties and an intermediate form produced, a sort of average in height between the too low and the too high?

In crossing rabbits, for instance, it is claimed that if short-eared rabbits and long-eared rabbits are crossed, the resulting bunnies will have either short ears or long ears, not in-between. In other words, this is a fixed factor. But with the 'mums I wanted to change the height of the plants. Fortunately it does not work like ears in rabbits.

Only a Few Worth Saving

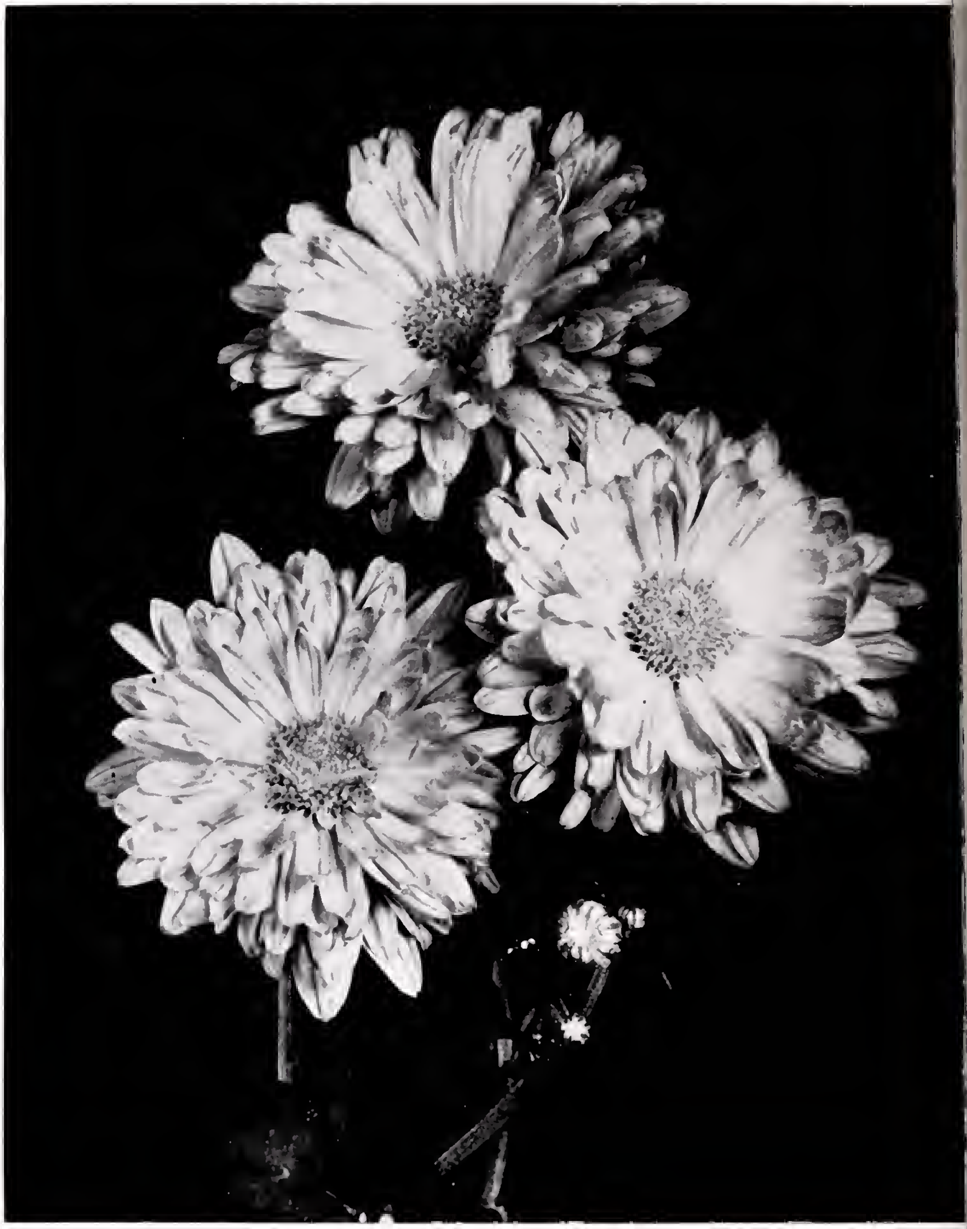
For one parent, to get type of plant and hardiness, a pink cushion variety was used. For the other parent all available double Korean hybrids were planted close by. The wind and the insects carried the pollen grains and thus did the crossing. From the seed resulting a few more than 100 seedling plants were secured the next year. Of these only two were of promise, which is a very good percentage; one was pink, and the other a good yellow. All the rest were discarded, being singles, while these two were semi-double, and of desirable bushy or branching type of plant, about 20 inches tall and almost as much across, making them suitable for landscaping and also for cutting with stems long enough to be satisfactory.

The next year these were re-crossed, one result of which was a double orange-yellow, afterwards named Summer Gold (U. S. Plant Patent No. 598), which was bought by the R. M. Kellogg Company, Three Rivers, Michigan; which firm also bought my first origination, Pink Dean Kay; and the newest one, with crimson flowers, named for Prof. Sam Williston, the great authority on the law of contracts, formerly of Harvard Law School, Cambridge, Massachusetts.

There are now many of the Dean Kay type, which was named for Dean George F. Kay, State University of Iowa, who died a couple of years ago. These are now available in pink, red, canary, white, lavender, and rose. Dean Ladd is really a "bronze" or red-orange of this type.

Photo. by Author.

Chrysanthemum Prof. Sam Williston. A new Mosnat variety with crimson flowers



U. of N. H. photo.

Chrysanthemum Dean Kay. A semi-double, rose pink variety that blooms early

In re-crossing more double type blooms ppear, but if there are half a dozen really good forms in 4,000 or 5,000 seedlings from seeds of the best double varieties, hat is doing quite well. A very lovely apple-blossom pink, fully double, appeared last year and is being further ested. It has proved entirely hardy. As previously mentioned one of the parents of the strain was a pink cushion 'mum and it is surprising how that pink color persists, with about half of the seedlings n pink colors. It was a prepotent parent as to color.

Earlier and Hardier

It is not unusual for these chrysanthemums to start to bloom in July and continue until hard freezes in the fall. Last year one called Orchid started to bloom the middle of June and bloomed constantly for about four and a half months. This variety as to color is described by its name, being pink with a lavender cast. The flowers have long stems, are large and somewhat of the Fantasy zinnia type, and excellent for cutting. The plant is rather smaller than the Dean Kay type, height 20 inches. Another interesting new variety from these crosses is a pure white, fully double, that has long but slender stems, and which some people say is pleasingly fragrant. Just recently white chrysanthemums are becoming popular, which they were not previously. Hybrids may be superior to either parent in some respects, as in hardiness. That factor in both of the parents has been intensified, together with the factors of earliness to bloom, and continued bloom. Thus there is now a branching or bushy type of really hardy, early and long-blooming chrysanthemum.

Propagation

This type develops root sprouts or rhizomes in the fall, while the old plant dies. If brought indoors to be wintered, they resent it and most of them die by spring; therefore, in late summer or early fall these rhizomes are used for propagation purposes, and lined out to get well rooted before winter. Then they are given a very light cover of leaves and a "V" trough, inverted, placed over them. Four-inch bevel siding makes a fine "V" trough, which stacks well, takes very little room, and is easily and quickly handled. Thus the plants freeze and remain frozen. It is the thawing and then freezing again that causes the trouble. It is surprising how much they will grow in cold weather, and even more so, the amount of roots that they will form, which is very important.

Trials of the Hybridizer

The hybridizer cannot be in any hurry in his work. It is a matter of years of effort to get the right answer to his problem. There will be many answers, but only a very few right ones. Plant patents have been granted in the United States for the past dozen years or so, but they are expensive and not every plant can be thus protected, when there are dozens of them. Also, it is desirable to send new plants to other locations for trial in another climate, with different soils and conditions. But the hybridizer must be careful to whom he sends his new creations for trial. There are a few who will recognize their value and appropriate them without any payment to the originator, and there is nothing much that can be done about it.

* * *

PROBLEMS IN SEED GERMINATION

Lela V. Barton

Illustrations furnished by the author

ALL of the problems encountered in regard to seed germination fall into two classes. The first of these is failure to grow when they are placed under conditions of moisture and temperature that ordinarily bring about germination. The other is the loss of viability between the time of harvest and the desired planting date. Only the first one of these will be considered in this article.

Causes of Failure to Germinate

Specific Requirements. The failure to germinate may be due merely to the requirement of specific conditions, especially as regards temperature and light, and may have nothing to do with "dormancy" as the term is commonly used. For example, seeds of annual delphinium do not germinate if planted at high temperatures. Very poor germination is obtained if the temperature is above 68° F. This presents a problem to delphinium growers who wish to plant seeds in the tropics or in summer in the temperate zone. These seeds may be induced to germinate at high temperatures, which are ordinarily inhibitive, by pretreatment in a moist medium at 50° or 59° F. for one, two, or three weeks. An electric refrigerator is satisfactory for this treatment. Seeds of the perennial form of *Delphinium* are not so sensitive to high temperature as the annual seeds but these also exhibit a favorable effect of low temperature pretreatment if the subsequent germination temperature is as high as 95° F.

Although wild columbine (*Aquilegia canadensis*) will germinate readily under a variety of conditions, too high temperatures must be avoided here als Constant temperatures as high as 77° F permit only a small percentage of th germination obtained when there is daily alternating temperature of 59° t 77° F. Honeysuckle (*Lonicera tatarica* seeds respond in the same manner.

Draba aizoides, Gentiana lagodechian Mimulus langsdorfii, and *Primula denticulata* germinate well over a fairly wid temperature range but at temperatures a high as 77° or 86° F. few seedlings ar produced. However, constant exposure to light at these temperatures have bee used to induce germination. Thus, ligh is the stimulating agent instead of lo temperature as in the case of delphinium

Other rock garden forms require lo temperature for germination, some actually germinating near the freezing point. *Camassia leichtlinii* germinate poorly at temperatures above 41° F. and *Lewisia rediviva* requires a temperature lower than 50° F. for germination.

Trailing arbutus (*Epigaea repens*) produces seedlings readily if allowed to germinate on top of moist filter paper under ordinary light conditions at room temperature. Seeds sown on top of soil watered from below, and covered above to prevent drying out also give fairly good seedling stands within six weeks to two months after planting. Light is thought to favor germination in this instance.

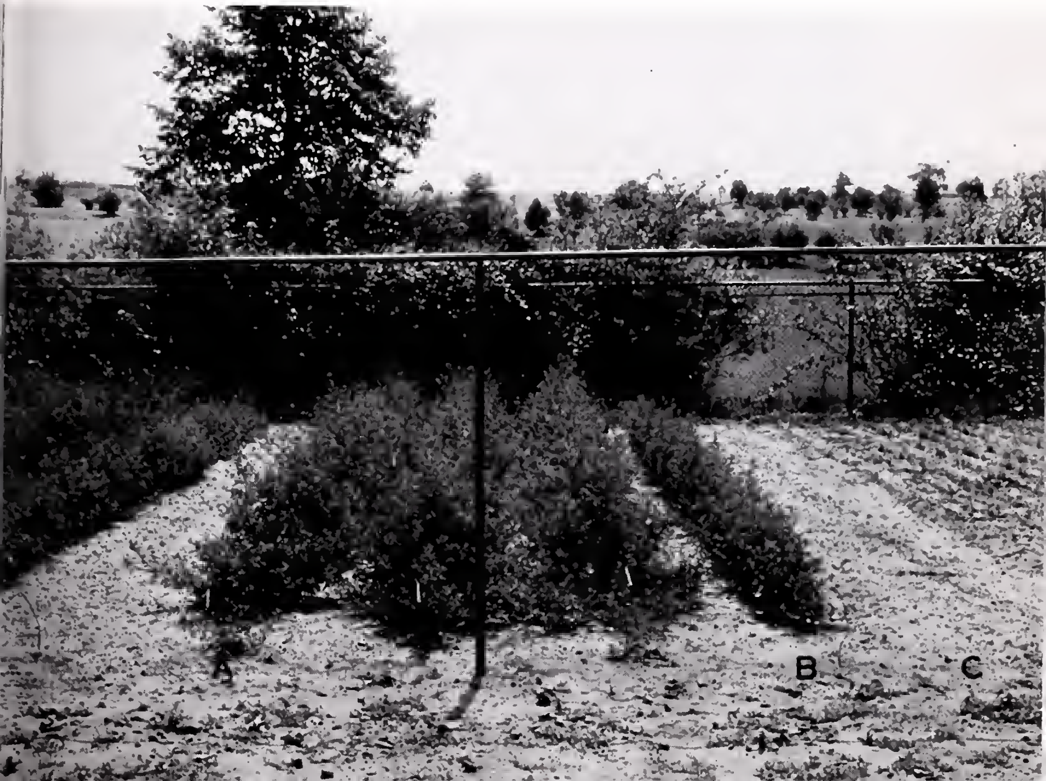
No germination of *Primula obconica* or *Ramondia pyrenaica* occurs even at favorable temperatures without some light.

There is a number of seeds whose germination behavior immediately after harvest is very different from that after a few months of dry storage. This phenomenon is spoken of as "dormancy" in freshly harvested seeds and "afteripening" in dry storage. Many weed eeds fall in this category, showing not nly a delay in germination but a capacity o distribute their seedling production ver a period of years. This is demontrated repeatedly by the years of cultiation necessary to get rid of weeds in a garden plot even if all weeds are eradiated as they appear and the introducion of new weed seeds avoided. The oil contains many fully imbibed yet ungerminated seeds which produce plants promptly when cultivation, excavation, or erosion gives them the moisture, temperature, and oxygen supply or the exposure to light required for their germination.

The survival advantage to the plant of delay in germination, due to specific requirements, is further demonstrated by seeds of certain winter annuals growing in desert regions. The germination of these seeds immediately after harvest, when the seedlings could not survive because of the heat, is prevented by their requirement of comparatively low temperatures, or alternations of low with moderately high temperatures for germination. An additional protection is the dormancy of freshly harvested seeds of these forms. This dormancy disappears by the second summer rainy season when the seeds germinate and the seedlings grow.

Dormancy in freshly harvested seeds is also prevalent in some of our common cereals such as wheat, barley, rye, and oats. This is an advantage to the grower in that there is no loss of grain due to germination in the shock. In fact, this character has such economic importance that grains are now being bred for dormancy in seeds along with disease resistance and other desirable features. Seed testing stations, on the other hand, find this factor a decided problem in testing cereal seeds for germination capacity,

Fig. 1. Impermeable seeds of *Melilotus alba*. A. Planted October 8, 1935 (3 rows). B. Filed seeds planted May 11, 1936 (1 row). C. Intact seeds planted May 11, 1936 (1 row). Photographed July 22, 1936.



since, at the temperatures normally used for tests, only the non-dormant seeds germinate. They have found, however, that all viable seed, both dormant and non-dormant, will germinate at approximately 50° F., so that a good index of the germination to be expected after a period of dry storage can be obtained immediately after harvest at this temperature. Similarly, testing laboratories have used daily alternations of temperature as well as light to determine the germination value of some of the grasses of meadow and pasture.

Impermeable Coats. Hard seed coats may be a cause of the failure to germinate. Many seeds of legume plants possess this characteristic. Any treatment which changes the seed coats making them permeable to water, followed by suitable sowing conditions, will bring about germination of these forms. Among the coat treatment methods developed are hot water or sulphuric acid treatments, filing or passing the seeds through abrading machines. The last method permits the treatment of large quantities of seeds. If the individu gardener has a few seeds, of wister or morning glory for example, whi he wishes to germinate, he may file t coats over the micropylar region bein careful not to file too deeply and inju the embryo. The filed seeds will the absorb water and germination wi proceed.

Fall planting of the hard seeds of th sweet clover, *Melilotus alba,* has bee effective in initiating germination in th region of Yonkers, N. Y., due perha to the breaking of the seed coats b freezing and thawing. Such a plantin is shown in Fig. 1, where it is compare with a spring planting of filed and inta seeds of the same lot. These seeds wer 100 per cent impermeable, the permeabl ones having been removed by soaking i water overnight and sieving out befor the tests were started. It should b recognized that in any one crop som naturally permeable seeds are produced In sweet clover the percentage of thes seeds at harvest may vary from 2 to 85 Thus, in treating all of the seeds of on

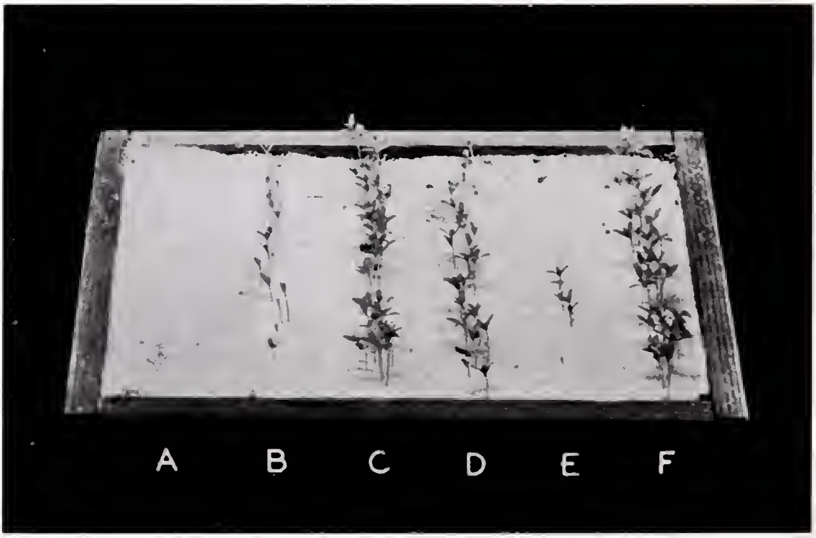


FIG. 2. Seedlings of *Dictamnus albus* produced in soil in the greenhouse from: A. Dry seeds; B, C, D, E, and F. Seeds kept in moist granulated peat moss for two months at 33°, 41°, 50°, 59° F., and refrigerator, respectively, before planting.

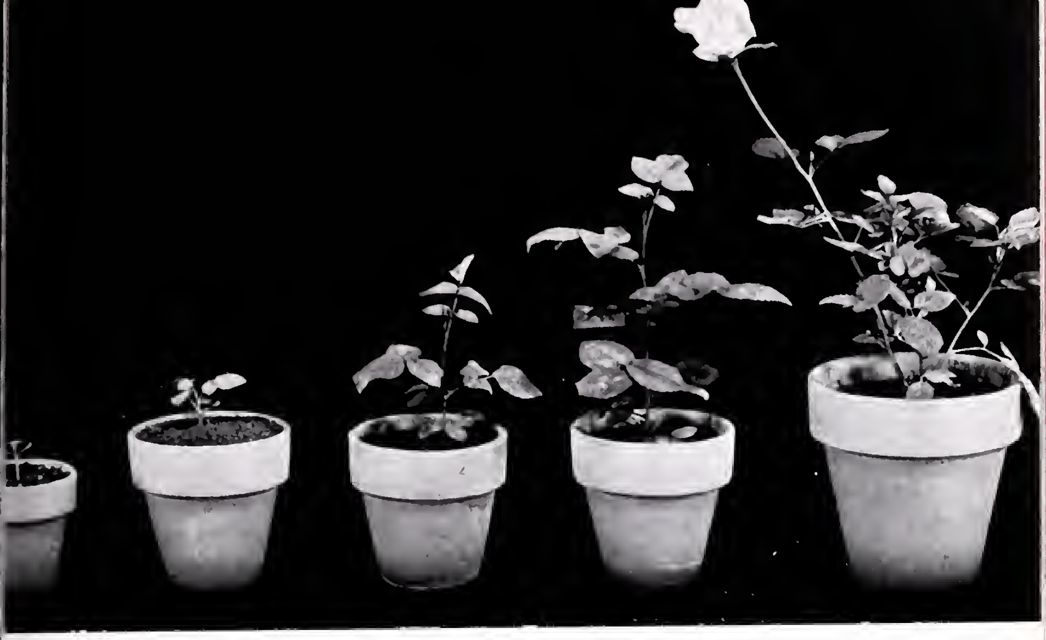


FIG. 3. Growth of rose hybrid seedlings in the greenhouse after germination of the seeds in moist granulated peat moss in the refrigerator. Left to right: 2 weeks, 1 month, 6 weeks, 2 months, and 3 months after transferring to soil in the greenhouse.

lot on a large scale some method must be used which abrades the impermeable coats without injury to the seeds with permeable coats. Mechanical treatment is safer than hot water or sulphuric acid for these mixed lots of seeds. It is not known whether fall planting would be effective for all hard-coated seeds. We have evidence at hand which indicates a difference in response of the different types of legumes. More experimental work is needed on this phase.

Dormant Embryos. The seeds of varied and numerous temperate zone plants possess dormant embryos. A well known method for bringing about their germination is low temperature pretreatment, generally known as "stratification." This process consists in placing the seeds in some moist medium, such as granulated peat moss, sand, or soil and placing them at 33° to 50° F. for certain periods of time. From one to several months in this condition is required for after-ripening the seed, depending on the species. At the end of the low temperature or after-ripening period, the seeds will produce seedlings promptly upon planting in soil in the greenhouse. In nature, the winter supplies the low-temperature period, so that, if the seeds are kept moist, they are after-ripened and prepared for germination the following spring. Seeds of water plants as well as those of land plants are affected. Water plantain, wild rice, bulrush, fringed gentian, wintergreen, bittersweet, spice-bush, flowering dogwood, spruce, pine, bayberry, and roses are among those plants having seeds which respond to stratification at low temperature. In Fig. 2 is seen the effect of a period of two months in moist granulated peat moss at various low temperatures before planting in soil in the greenhouse on the seedling production of the gas plant, *Dictamnus albus.* Note that 41° F. and an electric refrigerator approximating that temperature were most effective. Thirty-three degrees F. and 50° F. were less effective while 59° F. permitted very little after-ripening. No seedlings were obtained in this experiment from dry seeds planted in the greenhouse. As a rule various crops of the same species of seeds react in a consistent manner as regards dormancy responses. This is not necessarily true for hybrids, however. For example, seeds of *Rosa multiflora* require about six weeks of low temperature pretreatment while those of *Rosa rubiginosa* require six months. Because it is difficult to determine the requirements of hybrid rose seeds, the best plan is to mix the clean seeds with moist granulated peat moss and place them in a bottle with an open top in the refrigerator. Add moisture as needed. Remove the young seedlings as they appear and plant them in small individual pots in soil. Some of the seeds may sprout in two months, others may require two years. Once they have produced small roots and are transferred to pots they grow quickly in the greenhouse. The speed of growth for some rose hybrids is shown in Fig. 3, where a flower was formed three months after the young seedling, produced in moist granulated peat moss in the refrigerator, was transferred to soil in the greenhouse.

Many of the seeds which are favorably affected by low temperature pretreatment exhibit a partial dormancy of the embryo. When these embryos are removed from the coats and placed in germinators without low temperature pretreatment they grow very slowly and the tops produced by such seedlings are dwarfed. This condition has been reported for the Japanese rose tree, peach, apple, and hawthorn, all of which belong to the rose family. If grown at 62° F. or above, they remain dwarfs for six months to a year and a half, after which one or more buds start to grow. If, at any time, the dwarfs are exposed to 41° F. or lower for two months, the dormancy is overcome and vigorous growth follows promptly upon removal to a higher temperature.

A Combination of Impermeable Coats and Dormant Embryos. It has been pointed out in the foregoing section that, in order that after-ripening of the embryo may proceed, the seeds must not only be at a relatively low temperature but must also be in a moist medium. This implies that the seed must have absorbed water before the necessary changes can take place. Obviously then if a seed possessing a dormant embryo also has an impermeable coat, coat treatment must be given preceding the low temperature. Seeds of *Tilia americana*, *Symphoricarpos racemosus*, *Halesia carolina*, and *Coton-*

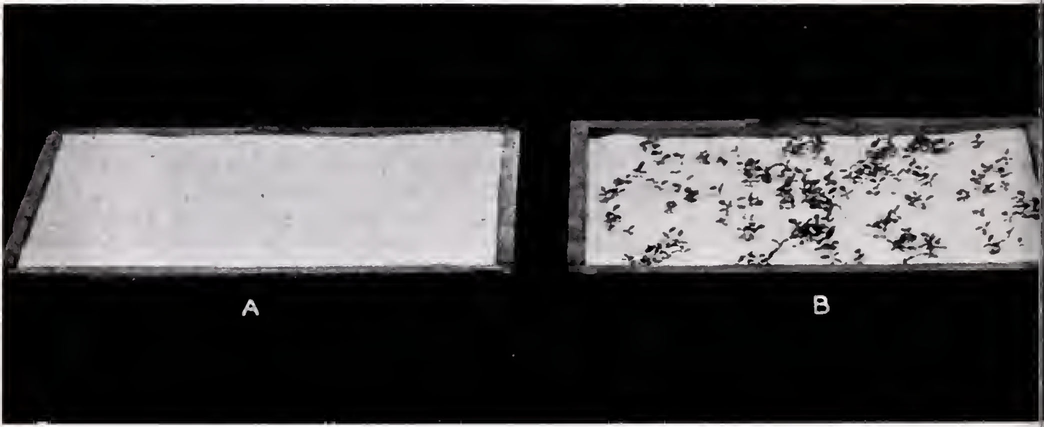


FIG. 4. *Cotoneaster divaricata* seeds planted in soil in flats and kept at 41° F. for two and one-half months after which they were removed to the greenhouse where seedlings were produced. A. Intact seeds. B. Seeds treated with concentrated sulphuric acid for two and one-half hours before planting.

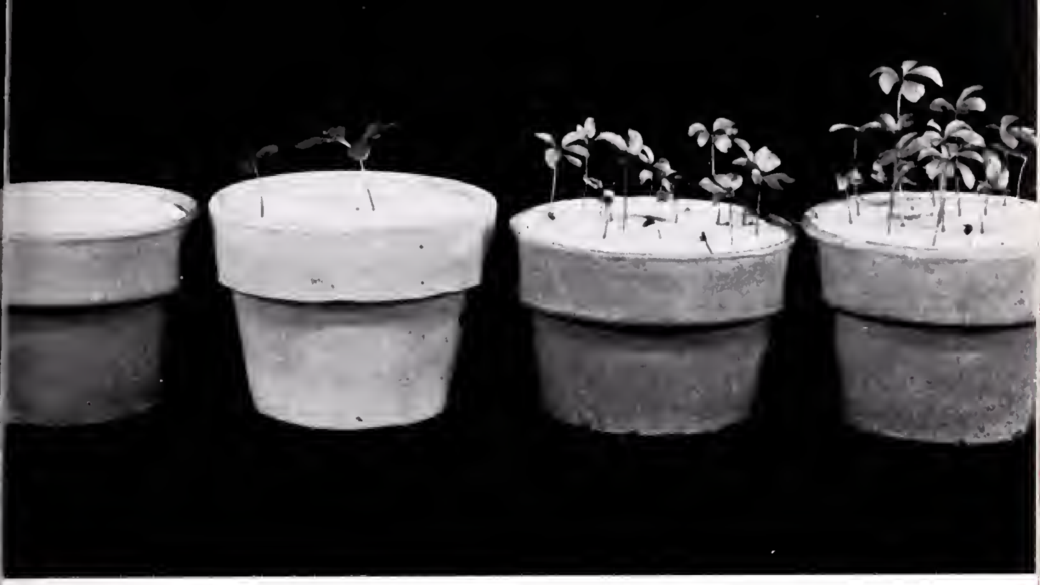


FIG. 5. Herbaceous peony seedlings produced in the greenhouse after pretreatment of germinated seeds at 41° F. for (left to right) 0, 1 month, 2 months, or 3 months.

caster sp. are mong those with this double hindrance to germination. Planting in soil and leaving at a temperature of approximately 70° F. for some time may remove the coat effect by permitting the soil organisms to attack the coats bringing about sufficient degeneration to allow the seeds to absorb water. A transfer then to low temperatures for the required length of time completes the pretreatment necessary for germination. Any effective coat treatment may be used instead of the period at high temperature. *Cotoneaster divaricata* seeds germinate if they are planted in soil and left for three months at 58° to 77° F., then transferred to 33° to 41° F. for three months, and then again to 58° to 77° F. for seedling production. The same effect can be obtained by a spring planting out-of-doors in a region with the approximate temperatures of Yonkers, N. Y. Treatment of the dry seeds for two and one-half hours with concentrated sulphuric acid followed by thorough washing in large quantities of water to prevent heating eliminates the first long high-temperature period. The treated seeds should then be planted in soil or any other moist medium and placed at low temperature for the effective period. Seedling production from such treatment is shown in Fig. 4. Note that the low temperature is without effect unless the seeds can absorb water.

Epicotyl Dormancy. Certain seeds produce roots readily when exposed to ordinary germination temperatures. The root systems develop until the stored food supply in the seed is exhausted, but no shoots are produced if the seedlings are kept continuously at these temperatures. It is necessary in these instances to expose the germinated seed, with the root system developing, to temperatures of 33° to 50° F. for a while in order to afterripen the epicotyl or the bud that forms it. A number of the "two-year" lilies, the tree peony as well as the herbaceous peony, some of the high-bush cranberries, and wild ginger are included in this group. Seedlings of herbaceous peony are shown in Fig. 5. Twenty seedlings with the roots growing were planted in each of these pots. Pots A and D were planted on June 30, pot B on August 5, and pot C on July 29. Since pot B was kept one month at 41° F. it was transferred to the greenhouse on September 5. Pots C and D were kept two and three months at 41° F. and were transferred to

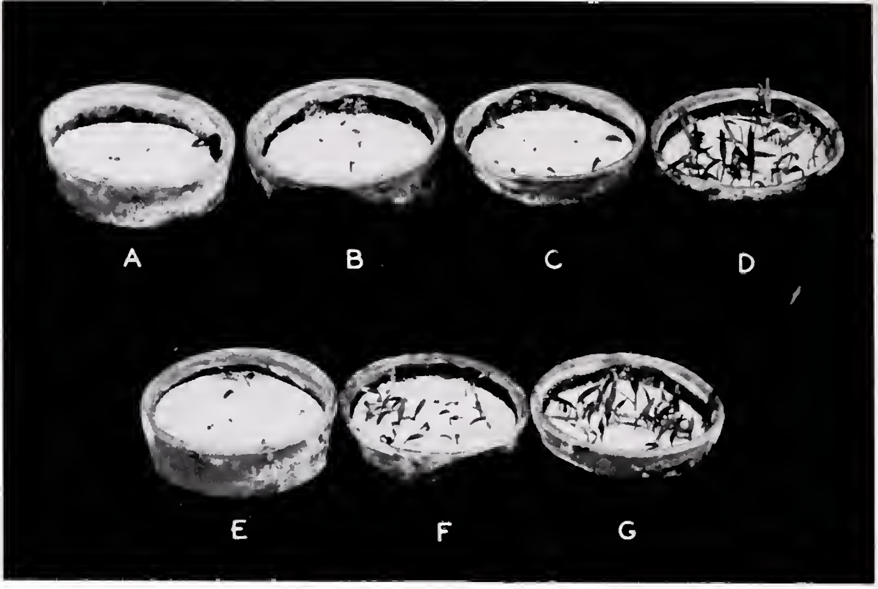


FIG. 6. *Trillium grandiflorum*, 1940 crop. One hundred seeds planted in each pot. Top row: 41° F. three months + greenhouse three months + 41° F. for (A), 0, (B) 1, (C) 2, and (D) 4 months, then replaced in the greenhouse. Bottom row: Initial treatment at 41° F. for (E) one month, (F) two months, and (G) three months followed by greenhouse three months + 41° F. three months, then replaced in the greenhouse.

the greenhouse on September 29 and September 30, respectively. Pot A was kept in the greenhouse continuously from the time the seedlings were planted. This photograph was taken on October 15, and leaves no doubt of the after-ripening effect of 41° F. on dormant epicotyls. Low temperature is without effect on the ungerminated seeds.

The practical method of handling seeds of this type is the same as for those in the preceding category, i.e., spring or early summer planting. The effect of the initial period at high temperature is different, however, for the two classes. In one instance it permits the microorganisms of the soil to make the seed coats permeable and in the other it favors the growth of the root system necessary before the epicotyl will after-ripen at low temperature.

A specialized type of epicotyl dormancy has been found in seedlings of *Convallaria majalis* and *Smilacina racemosa* in that the period at low temperature must be given, not merely after root production, but after the shoot has started to grow and has broken through the cotyledonary sheath. Exposure to low temperatures at earlier developmental stages is without effect in breaking epicotyl dormancy.

A Combination of Root and Epicotyl Dormancy. One might expect to find seeds with a combination of root and shoot dormancy. This would be distinct from the ordinary type of embryo dormancy where, once the growth of the radicle is initiated, the whole green plant follows quickly and from the epicotyl dormancy type where the production of the root at high temperatures is a prerequisite for low temperature treatment to force the shoot. Seeds of several forms have been shown to have this "double dormancy." From the foregoing discussion it would appear that these seeds would need a period at low temperature to after-ripen the root, followed by a period at high temperature to bring about actual sprouting and growth of the root, a second period at low temperature to after-ripen the epicotyl, and a second period at high temperature to grow the green shoot. This is exactly what is required. *Trillium grandiflorum*, *Trillium erectum*, and *Caulophyllum thalictroides*, show this separate dormancy of root and shoot. Such dormancy is overcome by two separate cold periods, one before the appearance of the root and the other after germination to form a root has already taken place. Some temperature effects on seedling production of *Trillium grandiflorum* are shown in Fig. 6. Other species showing epicotyl dormancy also show partial dormancy of the roots in that although some roots are formed without moist low temperature pretreatment of the seeds, a much higher germination results from pretreatment. Among these plants are *Convallaria majalis, Smilacina racemosa, Sanguinaria canadensis,* and *Polygonatum commutatum.*

Conclusion

This brief discussion of some of the many problems and characteristics of the seed germination process has indicated some of the methods developed to insure seedling production. The report is really concerned with a series of studies which has been made to determine which of the natural environmental conditions bring about the germination of specific seeds. Much remains to be discovered and to challenge the workers in this field.

[Explanation of terms which may be unfamiliar:
"*embryo*"—The young plant contained within the seed.
"*micropylar region*"—The vicinity of the micropyle, a tiny aperture through which the germinating embryo forces its way.
"*epicotyl*"—The stem part of the embryo.
"*radicle*"—The root part of the embryo.
Ed.]

* * *

A reminder that a greenhouse, even a small one, offers an opportunity to continue plant culture throughout the winter; and a cold-frame is useful for storing plants which are on the borderline of hardiness at the home of Mr. and Mrs. John C. Parker, Huntington, L. I.

KNEE GARDENS

Only the name is new

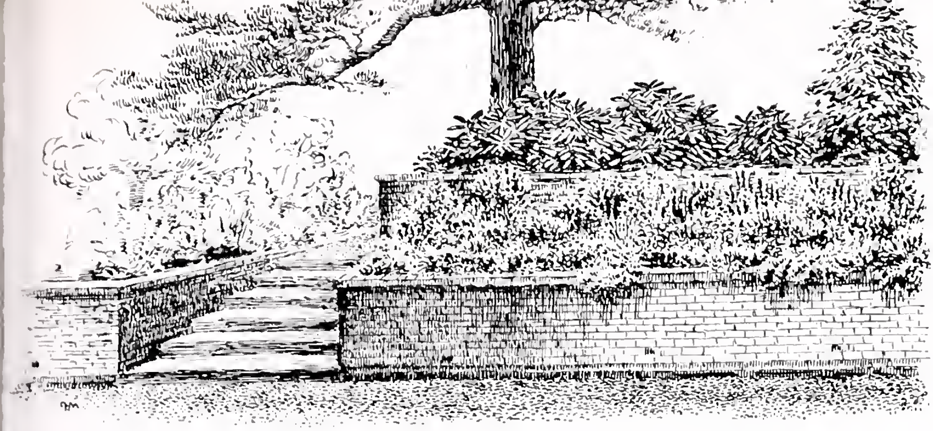
George S. Avery, Jr., with Maud H. Purdy

"GARDENING would be pretty good if it were not so near the ground"—an old but an ever-modern observation. Many agile gardeners feel that bended back and knee are part of good gardening, and a stimulus to good health, but when the knees grow stiff from one cause or another why not favor them and continue to garden? "Knee" gardens are the answer.

There are many appropriate places for knee gardens. If the lawn and garden are at different levels, with walls separating them, a knee garden will fit in perfectly. Or where terracing is necessary or desirable, knee gardens are easily put in. A recent visit to a terrace garden disclosed one knee garden above another, a real boon to those who find gardening irksome when it has to be done too near the ground. In a city garden, surrounded by a wall or wooden fence, build a knee garden at one end. The rock garden may also be a knee garden if one makes a walk through it with a dry wall on either side.

The construction of knee gardens should offer no particular difficulties. Stone, brick, cement and even wood are suitable materials, as may be seen in the accompanying pictures. And if a stone wall is built without mortar (dry wall), plants may be grown in the crannies between the stones. Here are a few points to know about: if your knee garden is to be in the full sun and facilities for watering are not readily available, the soil will dry out between rains. One answer to this is to mix ample moisture-holding compost with the soil, another is to change your mind about the location and build the garden in partial shade. In

Knee Garden with hill beyond. The stone wall is without mortar, and the picket fence gives a framing effect

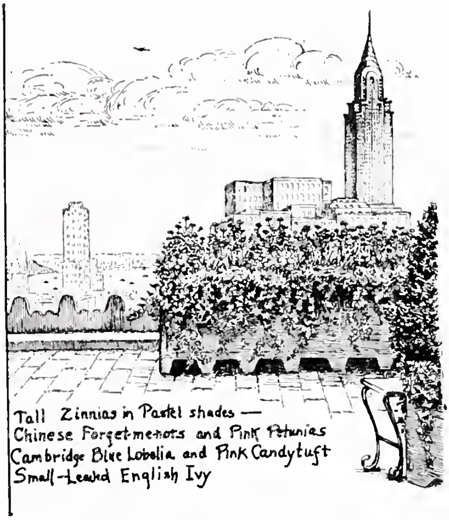


Knee Garden in a formal setting, with broad and narrow-leaved evergreens in the background

planning height of wall, be sure to accommodate the person who is to work in the garden. And let width of working space be limited approximately to an arm's length. In constructing the front wall leave toe space at the ground level for the comfort of the future knee gardener. And as to drainage: if the front wall is tightly built, such as of brick or cement, by all means put gravel in the bottom for drainage; or leave "weepers" —open spaces—in the base of the wall.

Planting the knee garden presents the usual problems. If chiefly spring bloom is wanted, bulbs are excellent; they flower early—which is good for the city garden. Tulips, daffodils, adonis, crocus, leucojum, miniature narcissus and grape hyacinth are all good material. Useful early-blooming perennials might include bleeding heart, wisteria, *Iris cristata*, etc. For continuous summer bloom, one may add other perennials and such herbaceous annuals as dwarf snapdragon (or tall varieties if planted in the background), Chinese forget-me-not, ageratum and anchusa. Useful evergreens are daphne, Boston ivy, English ivy, pachistima, rock spray and euonymus (*Euonymus Fortunei* (*radicans*) *vegetus*).

Knee Garden in a city backyard. The wisteria, tulips, bleeding heart, pansies, etc. are all for a spring garden



Tall Zinnias in Pastel shades —
Chinese Forget-me-nots and Pink Petunias
Cambridge Blue Lobelia and Pink Candytuft
Small-Leaved English Ivy

Knee Garden for the pent house

Plan the construction work this fall or early winter, and have your knee garden in full bloom next spring and summer.

DO PLANTS, TOO, HAVE CANCERS?

Philip R. White

CANCER is today, as it has been since earliest historic time, recognized as one of the great scourges of mankind. Anything which can contribute even in the smallest degree to our knowledge of its nature may be of great importance.

Plants often develop growths called galls, burls, or warts. These frequently possess some of the appearance of cancers. Unlike the human disease, however, they can always or at least almost always, be traced to definite causes—insect stings, molds, worms, friction, chemical injury, excess water, etc. Among the best known and most intensively studied of these is the "crown-gall" which is caused by a bacterium (*Phytomonas tumefaciens*).

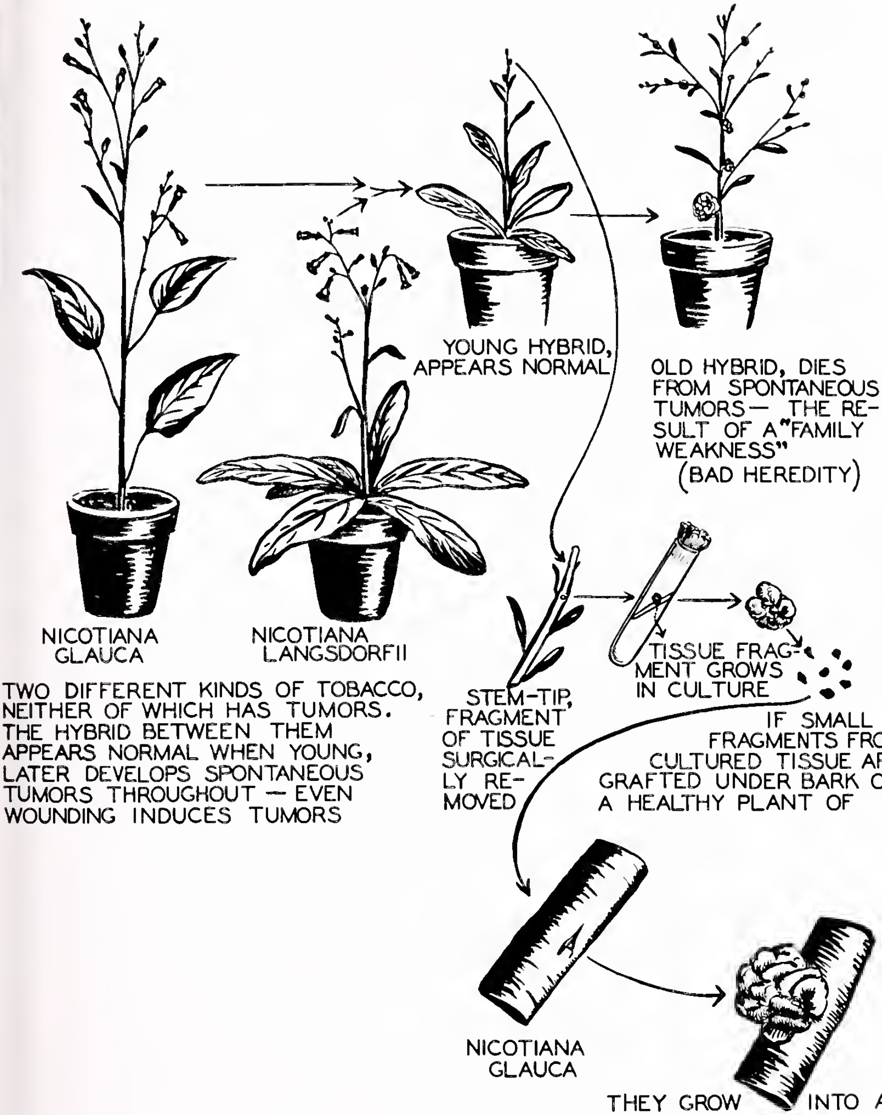
Twenty years ago, upon the urging of Dr. Erwin F. Smith, one of the early students of crown-gall, I set out to develop a technique for growing, in carefully controlled nutrients, small bits of tissue isolated from plants. This is the technique known as "tissue-culture" and had long been used in the study of animal tissues. The idea was to grow a small mass of plant tissue, then supply the bacteria or other gall-producing agents, and study the way in which tumors arise. Previous attempts to develop such a technique had been unsuccessful and as late as 1927 the problem was publicly declared by an eminent authority to be hopeless.

A method was first developed for growing plant roots, building on previous work of another American, Robbins, and a German, Kotte. This was successful in 1934 and by its use suitable nutrients and procedures were worked out in detail. Since then, using these methods, three types of plant tumors have been studied with some success.

First of all, there had long been know a "cancer family" among plants belonging to the tobacco tribe (fig. 1). If tw sorts of tobacco were hybridized thei progeny carried a hereditary defect whic caused them to produce tumors at an point that was wounded, even slightl Such tumors tended to spread until th plant was finally destroyed. Using th "tissue-culture" technique, portions o these tumors were isolated in test tube where they have been grown for mor than five years. Their growth is of completely disordered type, as is that o many cancers. After long cultivation i "tissue culture," pieces were remove and grafted under the bark of health plants of the species used as parents i producing the hybrids. Here they gav rise to new tumors similar to the original. These growths and other "graf tumors" to be described later, all aris exclusively from the transplanted cells not from host cells; that is to say, ther is no indication of *infection* of the host This is entirely comparable to the behavior of graft tumors in animals.

Second, the same sort of test was performed with a similar disordered growth The "crown-gall" bacterium in mos plants produces tumors only at the poin where bacteria themselves are present But in certain plants of the daisy an aster type, and especially in the sunflower, tumors which are called "secondary" appear at some distance from the point of inoculation (fig. 2). Smith had described these in 1912 but believe that they contained bacteria. Their existence was placed in doubt in 1922, but they were rediscovered in 1940 by Armin C. Braun. Braun believed that they did *not* contain bacteria. Since they continued to grow as typical "galls" this would mean that their cells had undergone some

FIG. 1 A "CANCER-FAMILY" OF PLANTS


NICOTIANA GLAUCA
NICOTIANA LANGSDORFII
YOUNG HYBRID, APPEARS NORMAL
STEM-TIP, FRAGMENT OF TISSUE SURGICALLY REMOVED
TISSUE FRAGMENT GROWS IN CULTURE
NICOTIANA GLAUCA

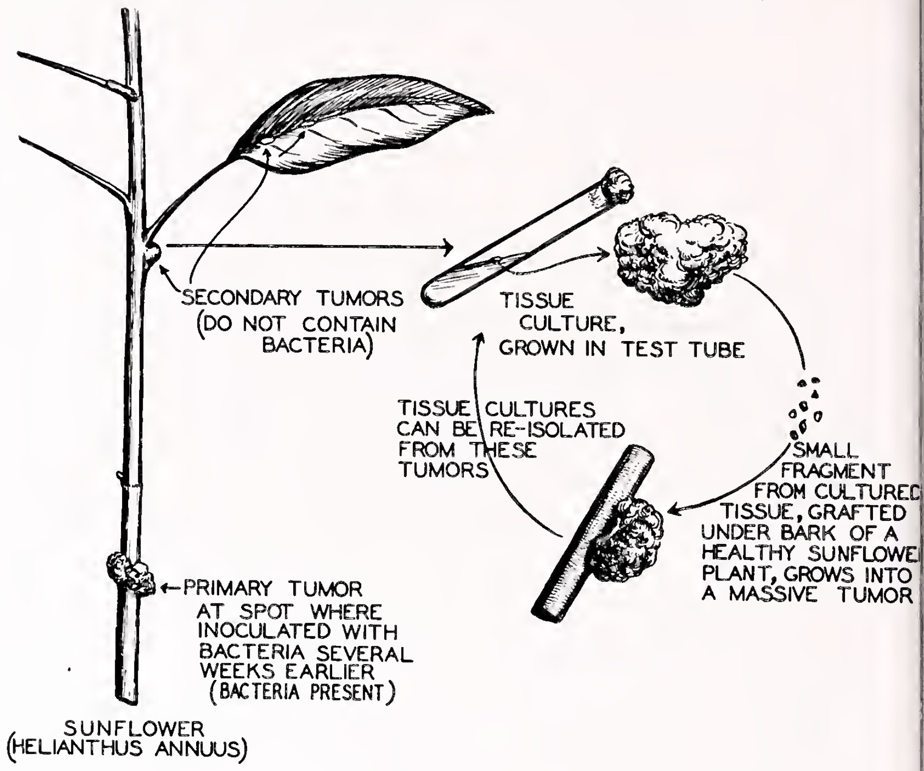
OLD HYBRID, DIES FROM SPONTANEOUS TUMORS — THE RESULT OF A "FAMILY WEAKNESS" (BAD HEREDITY)

TWO DIFFERENT KINDS OF TOBACCO, NEITHER OF WHICH HAS TUMORS. THE HYBRID BETWEEN THEM APPEARS NORMAL WHEN YOUNG, LATER DEVELOPS SPONTANEOUS TUMORS THROUGHOUT — EVEN WOUNDING INDUCES TUMORS

IF SMALL FRAGMENTS FROM CULTURED TISSUE ARE GRAFTED UNDER BARK OF A HEALTHY PLANT OF

THEY GROW INTO A MASSIVE TUMOR. ONLY THE GRAFTED TISSUE (PREVIOUSLY TUMOROUS) GROWS INTO THE LARGE TUMOR — THE "DISEASE" DOES NOT SPREAD INTO NICOTIANA GLAUCA TISSUE

FIG. 2 AN "OCCUPATIONAL CANCER" IN PLANTS


SECONDARY TUMORS (DO NOT CONTAIN BACTERIA)
TISSUE CULTURE, GROWN IN TEST TUBE
TISSUE CULTURES CAN BE RE-ISOLATED FROM THESE TUMORS
SMALL FRAGMENT FROM CULTURED TISSUE, GRAFTED UNDER BARK OF A HEALTHY SUNFLOWE PLANT, GROWS INTO A MASSIVE TUMOR
←PRIMARY TUMOR AT SPOT WHERE INOCULATED WITH BACTERIA SEVERAL WEEKS EARLIER (BACTERIA PRESENT)
SUNFLOWER (HELIANTHUS ANNUUS)

permanent and irreversible change from "normal" cells to "cancer" cells, presumably as a result of some chemical substance given off by the crown-gall bacteria present elsewhere in the plant. This is so much the sort of thing that we *believe* takes place in the production of animal and human cancers (not caused by bacteria, but by some other unknown irritant such as the cancer-producing chemicals) that it seemed very important. It was possible to grow tissue from these "secondary tumors" in culture, and they were grown in test tubes for three years. These again were grafted back into healthy plants. The grafts produced typical tumors not only in sunflower but also in the closely related artichoke. They can be passed back and forth between these hosts, re-isolated as tissue cultures and manipulated in many ways. And they are completely free of bacteria. Their cells have, indeed, undergone a permanent "cancerous" change.

Why the bacteria disappeared from these "secondary galls" (if indeed bacteria were ever present therein), we d not know. But a method of destroyin bacteria is known. This is "fever the apy." If a human being infected wit paresis is given a fever, either by us of drugs, or with radio waves, the in fecting organisms *may be* destroye The difference between the temperatu which kills the organisms and that killin the man is not great, so that results a somewhat uncertain, but it is a well e tablished method. Most plants will n stand temperatures high enough to ki crown-gall bacteria. But some tropic ones will. Working with a periwink plant from Madagascar, Dr. Braun wa able to show that the bacteria could b so destroyed and that if "fever trea ment" was begun at any time *after* th second day following infection, the gal developed normally (fig. 3). In oth words, whatever cancerous change the tumor cells had undergone was complet and irreversible, within a relatively sma number of *hours'* contact with the bac teria. Tissue cultures were isolated fro

iese "fever treated" galls, this time
·eed of bacteria by a *known* method,
rown in test tubes, and large typical
imors were again produced by grafting
ich tissues back into healthy plants.

There are also tumor-like growths pro-
uced by certain of the so-called "plant
ormones." These are unlike those de-
:ribed above, however, since they cease
) grow as soon as the "hormone" treat-
ient is stopped. The cells have not un-
ergone any permanent change. Tumor-
roducing bacteria bring about certain
eactions characteristic of "growth-
ormones." Strains of crown-gall bac-
eria are known which have lost the abil-
ty to produce tumors, and these also
roduce no "growth-hormone" responses
lthough they multiply in the host plants
uite as rapidly as do tumor-producing
trains. These facts had led to the hy-
othesis that "growth-hormones" might
e one of the factors involved in the production of tumors and that perhaps those bacteria which were no longer able to produce tumors might merely have lost their ability to produce the hormones. Braun and Laskaris tested this hypothesis by applying non-tumor-producing bacteria and synthetic hormones simultaneously to plants (fig. 4). The results were striking, for these two agents, neither of which alone would produce a permanent tumor, when applied together produced typical tumors which lost their bacteria but continued to develop and could be transplanted to new hosts.

Fully synthetic plant cancers have not been produced. *All* the factors involved are not yet known. There are, however, at least five types of plant tumors possessing properties similar to those of animal cancers: 1) the hereditary tumors of tobacco where the change is permanent and of genetic origin, 2) "crown-galls" which result directly from the presence

FIG.3 "FEVER TREATMENT" CURES A PLANT OF A BACTERIAL INFECTION BUT DOES NOT CURE IT OF ITS "CANCER"

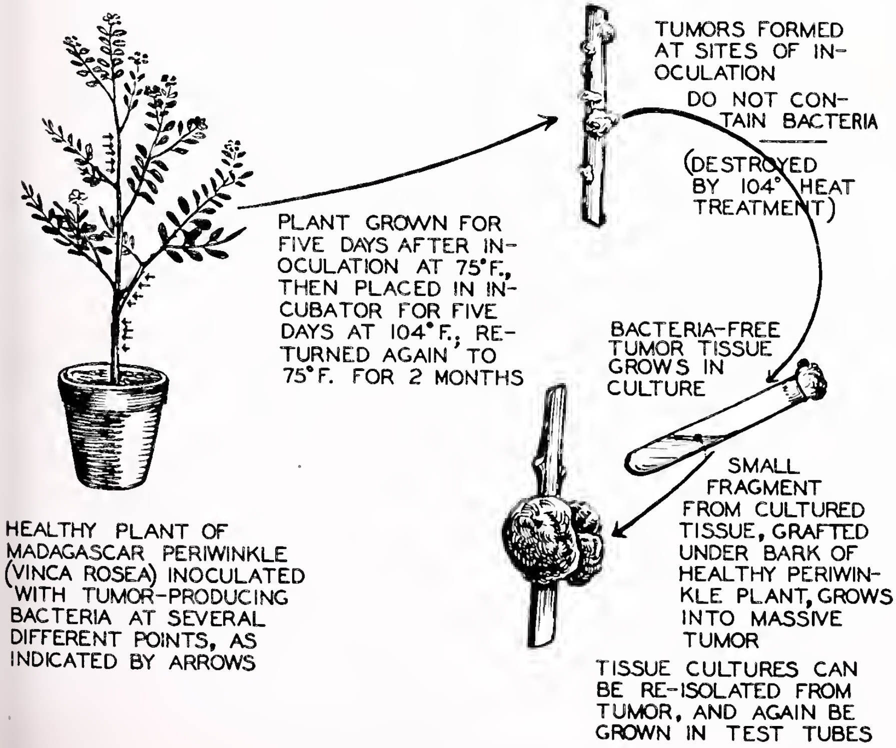
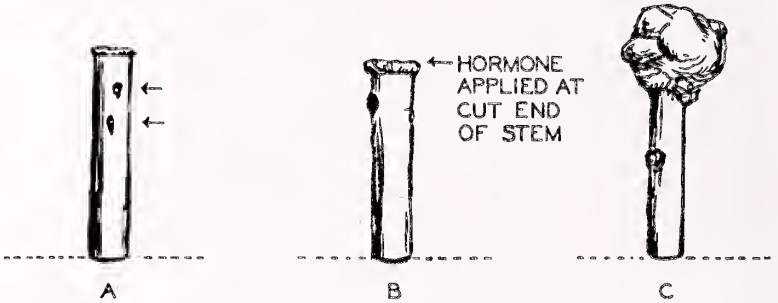

TUMORS FORMED AT SITES OF INOCULATION
DO NOT CONTAIN BACTERIA
(DESTROYED BY 104° HEAT TREATMENT)
PLANT GROWN FOR FIVE DAYS AFTER INOCULATION AT 75°F., THEN PLACED IN INCUBATOR FOR FIVE DAYS AT 104°F., RETURNED AGAIN TO 75°F. FOR 2 MONTHS
BACTERIA-FREE TUMOR TISSUE GROWS IN CULTURE
HEALTHY PLANT OF MADAGASCAR PERIWINKLE (VINCA ROSEA) INOCULATED WITH TUMOR-PRODUCING BACTERIA AT SEVERAL DIFFERENT POINTS, AS INDICATED BY ARROWS
SMALL FRAGMENT FROM CULTURED TISSUE, GRAFTED UNDER BARK OF HEALTHY PERIWINKLE PLANT, GROWS INTO MASSIVE TUMOR
TISSUE CULTURES CAN BE RE-ISOLATED FROM TUMOR, AND AGAIN BE GROWN IN TEST TUBES

FIG. 4 THE ROLE OF GROWTH HORMONES IN CAUSING PLANT "CANCERS"



PORTION OF GROWING STEM OF TOMATO PLANT WITH UPPER END CUT OFF, BUT WITH LOWER LEAVES AND ROOTS STILL ATTACHED—BUT NOT SHOWN

IF INOCULATED WITH A "WEAKENED" STRAIN OF CROWN-GALL BACTERIA JUST BELOW CUT END OF STEM (ARROWS), ONLY SMALL TUMORS ARE PRODUCED

TOMATO STEM TREATED WITH A GROWTH HORMONE (NAPHTHALENEACETIC ACID) PRODUCES IRREGULAR SWELLINGS WHICH RESEMBLE SMALL TUMORS BUT CAN NOT BE TRANSPLANTED TO ANOTHER PLANT (GRAFTED AS FIG. 1 TO 3) AND CONTINUE TO GROW

TOMATO STEM INOCULATED WITH "WEAKENED" STRAIN OF BACTERIA, AS IN "A", AND SIMULTANEOUSLY TREATED WITH GROWTH HORMONE AS IN "B", PRODUCES A MASSIVE TUMOR WHICH LATER LOSES ITS BACTERIA. FRAGMENTS OF SUCH TUMOR TISSUE MAY THEN BE GRAFTED INTO HEALTHY TOMATO STEMS, WHERE THEY WILL GROW INTO BACTERIA-FREE TUMORS IN 5 WEEKS (AS IN FIG. 1 TO 3)

of a bacterium and are permanent only so long as bacteria are still there, 3) "secondary tumors" which arise as an indirect result of bacterial infection but where the change is fundamental and permanent, and *not* dependent on continued presence of bacteria, 4) what we may call "fever tumors," again of bacterial origin, but the bacteria having been eliminated by heat treatment (again representing a permanent change in cell behavior not dependent on the continued presence of bacteria), and 5) the "growth-hormone" tumors produced b the interaction of a hormone and a non gall-producing bacterium, again representing a permanent cell change. In al of these the cells have undergone a cancerous transformation resulting in an uncontrolled, malignant type of growth, an in all except the second this change is permanent and irreversible.

It is believed that these tumors are ver like human cancers in many respects an that their further study may throw som light on this very serious problem.

* * *

First session of class in plant propagation, and use of hormones to hasten rooting

WITHIN THE BROOKLYN BOTANIC GARDEN

STUDENT RESEARCH WITH PLANT HORMONES

The idea of research is always an appealing one to young people of high school age, and when it was suggested last September that a problem in plant hormone research be started at the Botanic Garden, for some of the older members of the Boys' and Girls' Club, excitement ran high. Nine students were selected to start the project and others have since been added to the class. Week after week on Saturday morning these boys and girls have appeared faithfully. After ten months their well-sustained interest indicates more than a first flash of enthusiasm. They are learning by practice how scientific research is carried on.

The problem is one in the propagation of woody plants by cuttings, and two general objectives were outlined at the first session of the class. 1) To discover what time of year is best for successful propagation, 2) to discover whether hormone treatments will hasten rooting, or make more roots on cuttings of certain species. And there is also a social objective behind the project, i.e., to make new plants available for civic beautification. The species chosen for study included some not commonly used in foundation plantings and other kinds that are difficult to propagate. The list includes: *Arctostaphylos uva-ursi* (Bearberry), *Pyracantha coccinea* (Firethorn), *Lonicera iberica, Pieris japonica, Cotoneaster horizontalis, Ilex glabra* (Inkberry), *Taxus cuspidata* (Japanese Yew), *Rhododendron catawbiense*. (hybrids), *Viburnum dilatatum*.

For the most part the students have worked in pairs, each pair having two assigned plants. On the first Saturday of each month the young people gather their own material from selected specimens on the Botanic Garden grounds and prepare forty cuttings of each species. Twenty of these are treated with the hormone and twenty are left untreated as a control. Naphthaleneacetic acid mixed with ordinary talc is the chemical that is being used. The stems are moistened and the lower half-inch or so is dipped into the powder before the cuttings are inserted into the propagating bench.

Four small, glass-covered frames in the instruction greenhouses are used to house the cuttings, two for the treated specimens and the others for the controls. Each frame is divided into two parts, one of which is filled with clean, washed sand, and the other with a mixture of washed sand and peat moss. Cuttings of each species are inserted in both media. Various methods and devices are used to maintain the humidity in the frames, and routine care in ventilating and watering is provided by one of the staff gardeners.

After four weeks in the frames all the cuttings are lifted and examined, and roots, calluses, or casualties are properly recorded in a bound notebook. If the cuttings are well rooted they are potted up in 2-inch pots and carefully labelled Inspections continue at two week intervals as long as any of the set survive.

The plants are responding variously to the treatment. Some of the results are surprising, others are very disappointing but the students' records are being carefully kept and at any time any cutting can be readily located or accounted for

The idea of having high school students undertake experiments in plant research is not new, but the facilities at the Botanic Garden and the year-round program of the Department of Elementary Instruction offer unique possibilities for continuous and uninterrupted projects

This problem is scheduled to continue for at least a year, and the students are already asking if it can continue longer

FRANCES M. MINER

CARLUDOVICA, THE PANAMA-HAT PLANT

There are about 30 species of *Carludovica,* members of a small family (*Cyclanthaceae*) characteristic of the American tropics, where they are a conspicuous element in the undergrowth of the rain forest, but only one kind, *Carludovica palmata,* is used for making hats. It extends from southern Mexico to Peru, chiefly in lowland forests, and is also sometimes grown as a greenhouse plant in the north. The peculiar stringy flowers, which appear only rarely, are composed chiefly of masses of white filaments, well shown in the accompanying photograph from a plant in the greenhouses of the Brooklyn Botanic Garden. The fan-shaped or "palmate" leaves are borne on stalks up to 6 or 8 ft. in height and are about 2 to 4 ft. across. The fruit resembles that of *Monstera deliciosa*—a slender cone, with many close-packed green berries surrounding a scarlet axis which is exposed as the berries drop off This type of fruit is quite different from that of any palm; and the *Cyclanthaceae*, despite their palm-like leaves, are more closely related to the jack-in-the-pulpit, which belongs in the Arum family (*Araceae*).

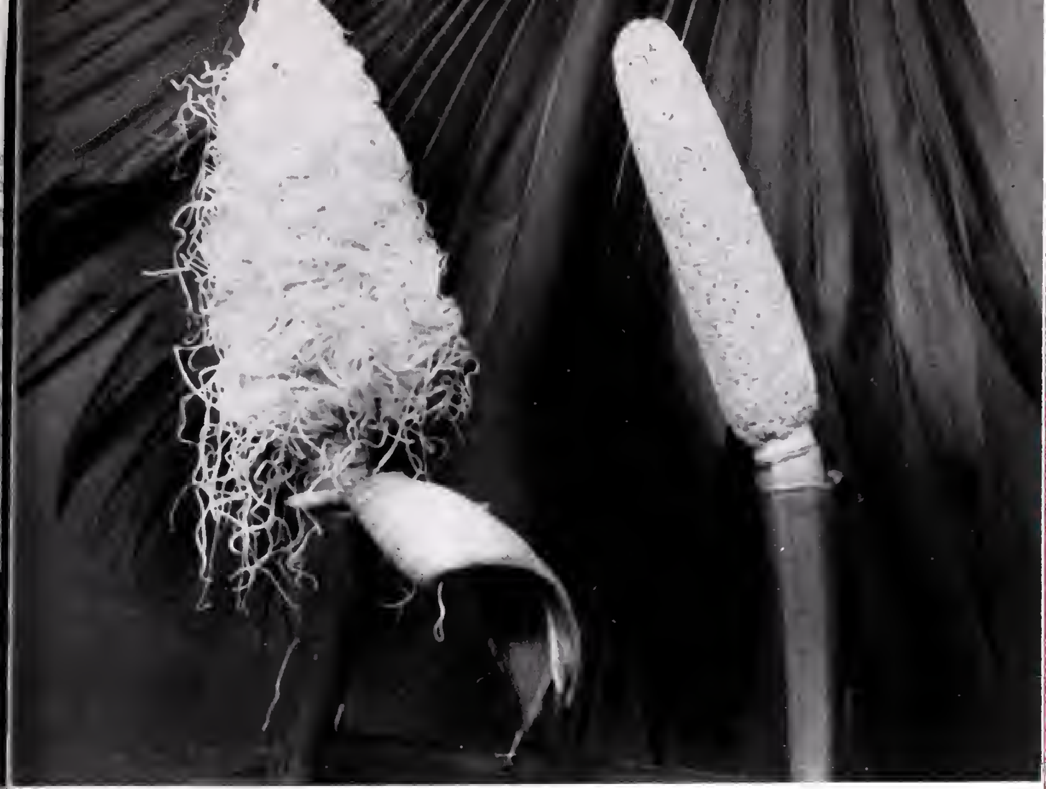


Photo by Russel T. Pansie.

Inflorescence of *Carludovica palmata.* Specimen grown at the Garden

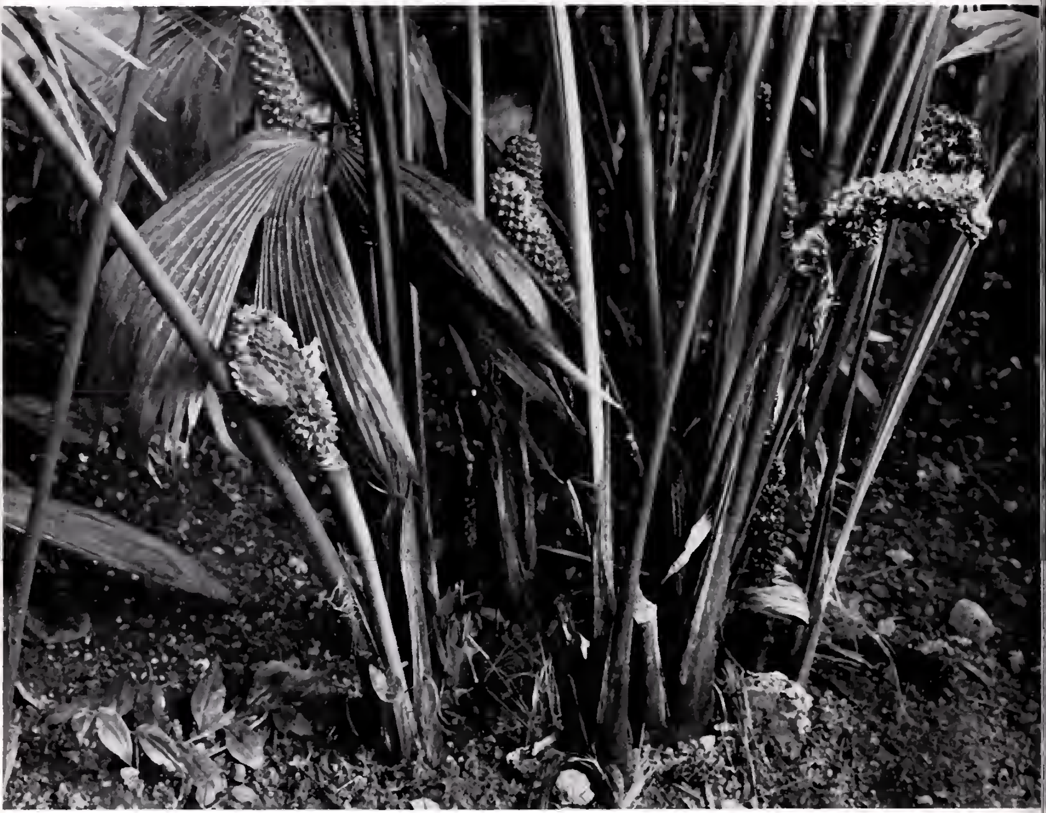
One Leaf to a Hat

It has been said that a Panama hat is made from a single leaf, but this statement would apply to very small hats. The leaf is selected in a very young stage before the fan has had time to open up. The leaf-blade is carefully cut into very fine strips without injuring the base, represented by the petiole stump. The shredded leaf is then placed in boiling water and later dried in the sun. It is then known as *toquilla* straw, and the individual dissected leaves are tied up in bundles for shipment.

Only in Ecuador does this plant appear to be used for weaving hats. Growing and preparation of the fiber is an industry concentrated in a small area along the southwest coast of Ecuador, where the climate is peculiarly humid due to the fog banks which roll in from the ocean during most of the year. This area extends from Montecristi and Jijijapa to Manglaralto, the plants being grown, along with *tagua* or "vegetable ivory" palms, at the borders of banana plantations. "Panama" hats were originally supposed to have come from Panama.

Where They Are Made

Some of the hats—the best ones—are woven in small factories at Montecristi and Jijijapa (pronounced "Hippihappa"). But the *toquilla* straw is shipped far and wide into Ecuador, and quite a large industry has developed high in the Andes, even at Cuenca, which lies at an altitude



Fruit of *Carludovica palmata*

of 8000 ft. Both here and in the lowlands the weaving is done by Indians, chiefly in their isolated huts. I have seen lights burning far into the night in stilt-supported thatched houses along the Ecuadorean coast, where the natives were at work on *toquilla* hats. These are woven over a wooden hat-block, the straw being kept moist by dipping it in a pan of water. This is probably the source of the erroneous statement that the best hats are woven under water. Fineness of weave largely determines the cost of the hat, and the best hats require several months of work. The finished hats are sold to dealers who take them to the towns, trim and sew the edges, and prepare them for the market.

A word more about *Carludovica*. The name was given by the famous Spanish botanists, Ruiz and Pavon, in 1794, in honor of Charles IV (Carlos in Spanish), King of Austria, and Queen Ludovica (Louise), both of whom were generous patrons of botanical exploration.

H. K. SVENSON

AMONG THE CONTRIBUTORS TO THIS ISSUE

Dr. Lela V. Barton, Asst. Plant Physiologist at the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., has been actively engaged in research on problems in seed germination and storage for many years.

Alex. Cumming, of the Bristol Nurseries, Inc., Bristol, Conn. Originator of the Korean hybrid type chrysanthemum and other well-known plants, including Gypsophila Bristol Fairy and Weigela Bristol Ruby. He was previously connected with the Department of Parks, Hartford, Conn.—a park department well known for its horticultural accomplishments.

V. R. DePetris, nationally known chrysanthemum hybridist, producer of many of our present commercial varieties. He was the recipient of the Massachusetts Horticultural Society's gold medal for outstanding work in horticulture and has pioneered the development of Arcticum hybrids for both garden and greenhouse culture. He is located at Grosse Pointe Farms, Mich.

Henry E. Downer is a graduate of the Royal Botanic Gardens, Kew, England. His work as Horticulturist at Vassar College has brought renown to that institution for the beauty and well-kept appearance of its campus.

George H. Gillies' cultural skill was recognized by the award of the Geo. D. Pratt Medal of Achievement in 1939, and the Special Trophy in 1941. He has been head gardener for Marshall Field at "Caumsett" for more than twenty years.

W. D. Holley received his B.S. in Horticulture at Texas Technological College, M.S. at Michigan State College. He was formerly at the University of New Hampshire, working on breeding and other problems of floriculture, and now is a member of the Horticultural Staff at the University of Connecticut.

Dr. Elizabeth Bindloss Johnson received her B.S. degree from Connecticut College, her Ph.D. from Columbia. She is a co-author of a forthcoming book on hormones and horticulture.

H. Roy Mosnat is a graduate of the State University of Iowa, attending law school there and at Harvard. He was admitted to practice law in Iowa and Florida, and has been in nursery work for the last twenty years or so, preferring laws of nature to those of man. He originated the Dean Kay strain of chrysanthemums and other similar "mums," in a climate difficult for perennials. He may be reached at Belle Plaine, Iowa.

H. Stuart Ortloff was a student at the Massachusetts State College and Columbia University. He is a well known landscape architect, a member of the Ortloff & Raymore firm, Huntington, N. Y. He is the author of "Garden Bluebook of Annuals and Biennials," "Color and Succession of Bloom in the Flower Border," and other books on gardens.

Dr. Ernest L. Scott, formerly Associate Professor in Physiology at Columbia University, grows chrysanthemums as a hobby, and is president of the Eastern States Chrysanthemum Society. The Scott's garden has been opened annually to the public during mid-October to mid-November and thousands have seen this well known display.

Dr. Philip R. White, Associate, Rockefeller Institute for Medical Research, Princeton, N. J., is a well-known plant physiologist, and has made many contributions on the culture of plant tissues in artificial media, many of which have a bearing on the cancer problem.

ROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

Winter, 1945

Digests of
Outstanding Articles
on
rticulture and Gardening
—1945—

—

A City Garden

—

Poinsettia and Holly

L. I NEW SERIES NO. 4
IN TWO PARTS—PART 1

BROOKLYN BOTANIC GARDEN
OF
THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

Officers of the Institute

EDWARD C. BLUM
Chairman, Board of Trustees

ADRIAN VAN SINDEREN
President

WALTER H. CRITTENDEN
First Vice-President

CHARLES PRATT
Second Vice-President

SIDNEY W. DAVIDSON
Third Vice-President

EDWIN P. MAYNARD
Treasurer

JAMES E. GIBBONS
Secretary

Ex Officio Members of the Board

The Following Officials of the City of New York

THE MAYOR THE COMPTROLLER
THE COMMISSIONER OF PARKS

Botanic Garden Governing Committee

PHILIP A. BENSON, *Chairman*

MISS HILDA LOINES, *Vice-Chmn.*
EDWARD C. BLUM, *Ex officio*
WILLIAM G. CREAMER
WALTER H. CRITTENDEN
LEWIS L. FAWCETT
MRS. LEWIS W. FRANCIS
ANDREW J. GONNOUD
WALTER HAMMITT
WILLIAM T. HUNTER
EDWIN P. MAYNARD
ROBERT MOSES, *Ex officio*
ALFRED E. MUDGE*
JOHN C. PARKER
DONALD G. C. SINCLAIR
ADRIAN VAN SINDEREN, *Ex officio*

Director of the Botanic Garden

GEORGE S. AVERY, Jr.

---

* Deceased Aug. 23, 1945.

PLANTS & GARDENS

Opuntia tortispina

New Series — Winter, 1945 — Vol. 1—No. 4

CONTENTS

Cover . . . . . Rock Garden in Winter
Frontispiece . . . . . Winter Scene in the Botanic Garden
Announcement . . . . . George S. Avery, Jr. 195
Layout of the Small Place . . . . . Alice Recknagel Ireys 196
Poinsettia: Mystery Flower . . . . . Arthur Harmount Graves 198
Your Poinsettia for and after Christmas Bloom . . . . . Conrad B. Link 201
The Christmas Hollies . . . . . Conrad B. Link 203
Lawns, Weeds, and 2-4-D . . . . . George S. Avery, Jr. 206

Articles Reprinted or Condensed

Ring out Wild Bells . . . . . Richardson Wright 210
Too Many Lilacs . . . . . George M. Fisher 215
Hybrid Vegetables . . . . . Donald F. Jones and Amanda Quackenbush 218
Hybrid Popcorn . . . . . Arthur M. Brunson and Glenn M. Smith 222
Do Vegetables Cross Pollinate? . . . . . Gordon Morrison 226
Sow Your Seeds on Sphagnum Moss
V. T. Stoutemyer, Albert W. Close, Claude Hope 227
Is Soil Testing the Answer? . . . . . Alex Laurie 230
Balanced Manuring . . . . . W. G. Ogg and Hugh Nicol 231
Too Many Fruits Spoil the Crop . . . . . George L. Slate 233
Uncle Sam, Gardener in Gravel . . . . . Captain Richard C. Davids 235
Embryo Culture of Iris Seed . . . . . L. F. Randolph 241
The Town with no Poison Ivy . . . . . Dorothy S. Towle 247
Within the Brooklyn Botanic Garden 248
Among the Contributors to this Issue . . . . . Page 3 of cover

Except where otherwise noted: drawings by Maud H. Purdy and
Margaret F. Piper; photographs by Louis Buhle

The present issue was brought together by the following editorial committee: Michalena Lefrere Carroll, Marjorie Loughlin Carson, Charles F. Doney, Miles Imlay, Sally Kelly, Patricia Brown Moore, Margaret F. Piper, George M. Reed, Hester M. Rusk, Margery H. Udell

---

Published quarterly at Prince and Lemon Streets, Lancaster, Pa., by the Brooklyn Botanic Garden, Brooklyn, N. Y. Entered as second-class matter, May 26, 1945, at the post-office at Lancaster, Pa., under Act of August 24, 1912. Subscription included in Botanic Garden membership dues. To others: $2.00 per year; $3.00 for two years.
Copyright, 1945, by the Brooklyn Botanic Garden.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
1000 WASHINGTON AVENUE
BROOKLYN 25, NEW YORK
TELEPHONE: MAIN 2-4433

Winter 1945

A CHRISTMAS THOUGHT FOR OUR FRIENDS:

Again and again one re-discovers that a lot of people think most plants are weeds. Weeds are so-named only because they grow where they are not wanted, and therein lies the problem. The great tragedy of our world is that there are weed-people, too. Most of them have a contribution for society, if they could only find their niche. The Christmas season might be a good time for us to contemplate this problem. It requires more thought and good will than it has ever had before. A tip toward the solution: the plant world solves its problems without strikes or wars.

Now about PLANTS & GARDENS:

The feature of this Winter Issue is thirteen of the year's articles of outstanding interest and significance, selected from gardening and horticultural magazines in this country and in Britain. It is a pleasure to honor the authors and publishers of the originals, by reprinting or condensing their articles in this Review number. All concerned have cooperated generously to make this possible.

The Winter Issue also completes the first volume. By all means bind it for later use -- there is an announcement about binders in this issue. The carefully prepared index will make every article of easy access for a long time to come.

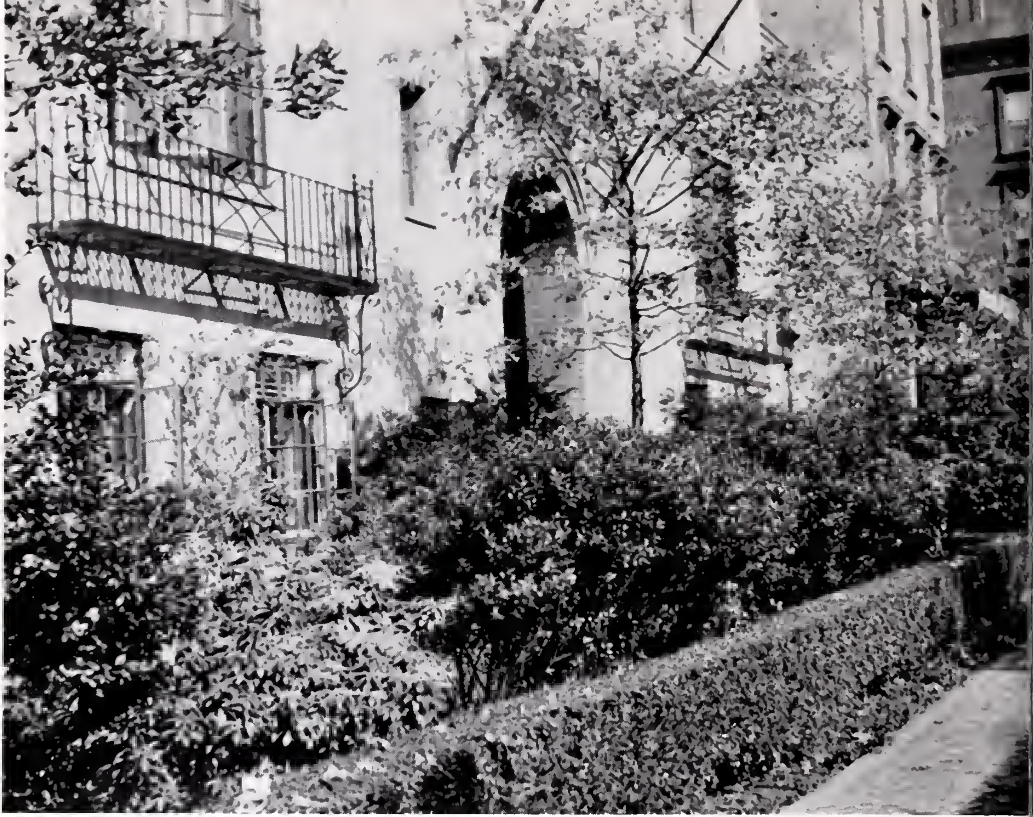
In reviewing the year we happily make certain acknowledgments. To Mr. Montague Free, our first Editor, we owe much, and he takes our good wishes with him to his new position on the editorial staff of the Home Garden. His thirty-one years at the Garden have left a deep mark, and a host of friends. To Dr. George M. Reed, in charge of publication, we are especially indebted. And to the numerous others, at the Garden and elsewhere, who have contributed to our pages or given help and suggestions behind the scenes, we are deeply grateful.

Our new Editor? It is a satisfaction to announce the appointment of Mr. John C. Wister, well-known horticulturist and landscape architect - see biographical highlights in the section "Within the Brooklyn Botanic Garden."

Greetings of the season, from all here.

Sincerely yours,

George S. Avery, Jr.
Director



Alice Reckn

A city entrance garden

LAYOUT OF THE SMALL PLACE

A city entrance garden

Alice Recknagel Ireys

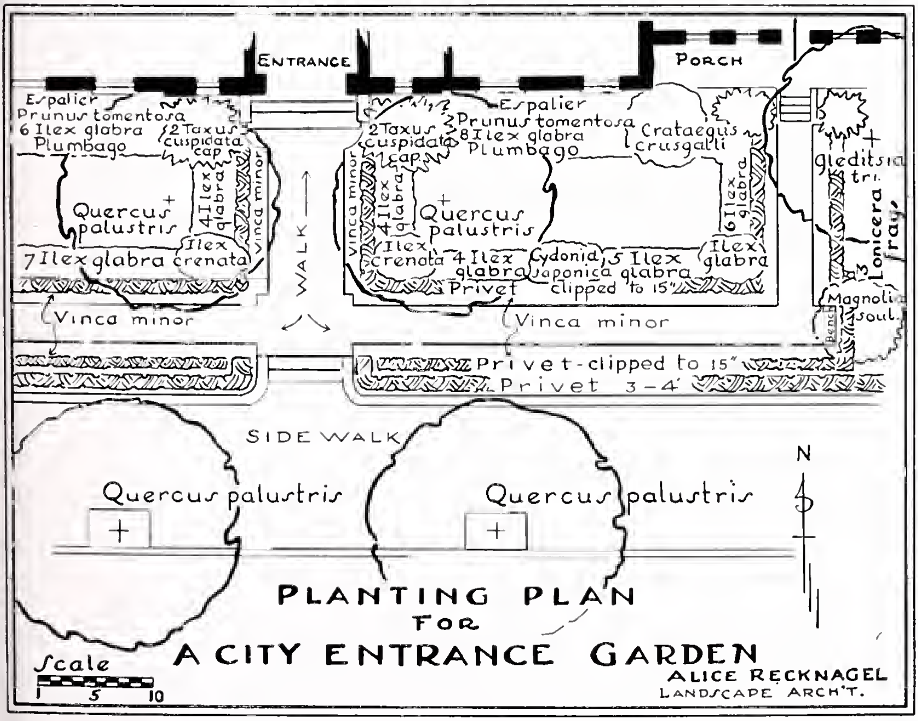
Landscape Architect

IN one of the residential sections of Brooklyn, a group of old brick houses has been remodeled into an attractive apartment house. One of the interesting features of this development is a sunken garden that faces the street. This formal garden with its small lawn panel and evergreen shrubs has stood the wear and tear of city life for a number of years and still maintains its well-groomed appearance.

The shrubs used are few. The shining bronze shrub that is so predominant throughout is really a holly, *Ilex glabra,* inkberry, as it is more commonly calle The taller plants at the corner are al hollies, *Ilex crenata,* Japanese holly. T other evergreen is lily-of-the-valley pla *Pieris japonica.* Its drooping clusters small white flowers turn into seed po and remain on all summer. The gre leaves have already appeared on the wi ter honeysuckle (*Lonicera fragrantissim* at the ends of the garden. When the plants are older they will have love fragrant blossoms in early March as th is the first variety to bloom. In the fir week of April there are tiny pink a white rosettes on the shrubs against t wall. These shrubs, Nanking cherr *Prunus tomentosa,* have been trained espalier form and make most interesting patterns against the wall throughout the year. The last two weeks of April will ordinarily see the lovely magnolias in bloom. This variety, *Magnolia Soulangeana,* has little fuzzy buds that are noticeable all winter and open long before the leaves appear.

Towards the end of April and in early May, the garden is at its height. The flowering quince, *Cydonia japonica,* that old-fashioned shrub in the center of the planting area, will be in bloom. At the same time the pure white blossoms of the hawthorn tree will command your appreciation. By the middle of May the red buds of the oak trees will burst into fresh green. And a bit later the tree in the corner which so far has looked dead will start to leaf. It is a honey locust, *Gleditsia triacanthos.* Although this is slow in starting, the leaves stay on late in the season and feathery seed pods appear in the fall. The edging along the walks is one particularly adaptable for city gardens. It is the familiar ground cover—myrtle, *Vinca minor.* The hedge is a low-growing type of privet, such as Regal Privet, and is kept clipped eighteen inches high. During the summer the garden has a cool green appearance due to the use of the selected evergreens. By late summer the bright blue border of plumbago, *Plumbago Larpentae,* will start to flower, and it remains until frost. Then the chrysanthemums have their show of bright yellow and red.

When winter comes there will still be the dark, shining evergreens to look at and enjoy. Thus the year is rounded out with the garden having given a pleasing effect through the four seasons.



POINSETTIA: MYSTERY FLOWER

Some new slants on this unusual plant

Arthur Harmount Graves

POINSETTIA is a plant of many names: Christmas Flower to some; Easter Flower (*Flor de Pascua*) in Central America; Pastora in Costa Rica; also, Lobster Flower, Mexican Flame Leaf; or, in these United States just plain Poinsettia.

In some unaccountable way a specimen of the plant crept into the herbarium of Willdenow, a distinguished German botanist of the early 1800's. There it was labeled *Euphorbia pulcherrima.* In 1828 Dr. Joel Poinsett, during his travels in Mexico, rediscovered the plant, sending specimens to Charleston and later to Philadelphia. In his honor it was rechristened *Poinsettia pulcherrima,* although botanists have by no means universally adopted the new name.

Now the question is, where is the home of this magnificent plant? Where does it grow "wild" and in what kind of environment? A reputable German botanist has stated that its habitat is "shady, moist regions" of Mexico and Central America, and in his mind's eye one sees openings in the tropical forest beyond man's ken, illuminated with these gorgeous plants, whose crimson color flashes and gleams here and there in the subdued light. But one searches the literature in vain for any full description of the natural environment. It is common in cultivation in Mexico and the Central American States, in the Bahamas and Bermuda, in fact anywhere below the frost line, for it is not hardy. We find a note in the *Gardener's Chronicle,* 3rd Series, Vol. 21, p. 125, accompanying a photograph of a large poinsettia plant eight years old, at Santa Barbara, Calif., about 15 feet in diameter and 12 to 15 feet high, which the writer states is cut back strongly each year, and adds with characteristic Californian pride that "it will show what we can accomplish in gardening on this coast where heads of poinsettia two feet across have been measured by myself."

After a prolonged search for a description of the habitat of the plant, we wrote to Dr. Paul C. Standley, formerly Curator at the U. S. National Museum at Washington, D.C., now Curator at the Chicago Natural History Museum. Dr. Standley, a recognized authority on Central American plants, was good enough to write us somewhat at length on the subject, and the following are excerpts from his letter.

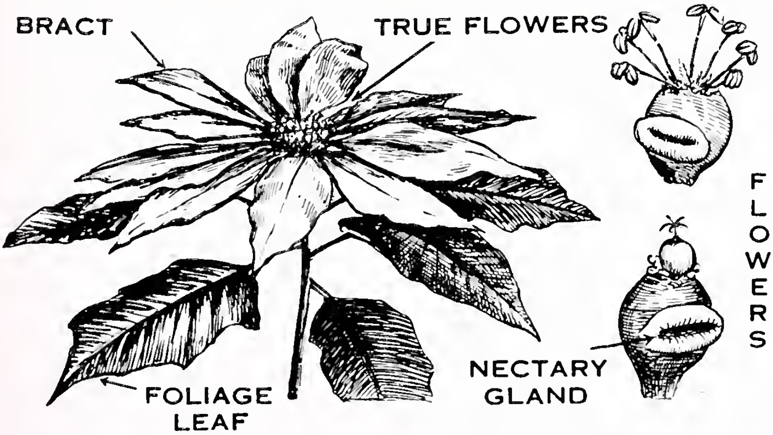
"I will agree that it is not an easy matter to get definite information about the poinsettia in Mexico. I have never been in any part of Mexico where it might be expected to be native, and one can tell nothing from the herbarium labels. Prof. Maximino Martinez has written me that he believes it does grow wild in the country—he has traveled there about as widely as anyone and is a very observing man, of things in which he happens to be interested. Before accepting his statement, I should like to see the plants as they grow 'wild,' although perhaps I could tell no more about the matter than now.

"In Central America I have seen the poinsettia only once in a place where it could possibly be a native plant. That was in a little ravine on the road near Jalapa, Guatemala, where it grew high up on steep cliffs, in a rather wet and very shady place, with no introduced plants in the immediate vicinity. The plants were typical, rather straggling shrubs, with the floral leaves less well developed than usual. I can well believe that that is the sort of a place where poinsettia might be native. It is much used for decorative purposes in Guatemala, as everywhere else in Central America, and the Indians during some hundreds of years may well have exterminated the plants, which they like for offerings on altars, etc. Seeds might have reached that spot in the ravine by birds, which doesn't seem probable if even possible. Also I can imagine some Indian carrying a plant up there and setting it in the ground, above some former wayside cross. I just don't know. Poinsettia plants probably could not compete with ordinary native vegetation. They do grow about houses with little or no care and much mistreatment, rags spread over them to dry, and chickens roosting on the branches. They also grow well in hedges, where they are no better treated. I should have mentioned that the possibly natural locality in Guatemala lies at probably 4500–5000 ft.

"Up in the dry barren highlands of the departments of Quiche and Huehuetenango (Guatemala), the soil so sterile that the corn is unbelievably poor, there is something rather curious about the use of poinsettia. The winter climate is rather severe, especially because of almost continuous winds. As a result most of the adobe Indian houses face the southwest, and only on that side are there any openings. During the dry season (our winter) the ground is everywhere bare, because of the sheep and goats, and there are no flowers about the houses, something unusual for Indians. However, beside almost every one of these isolated dwellings there is a bush of poinsettia, and in its season each of these bushes blazes almost like a bonfire, and is often more conspicuous than the house itself. I have suspected that the plant may have some religious significance, as other plants do, and that this custom may be an old one. . . ."

Dr. F. R. Fosberg of the U.S.D.A., a recent visitor to the Garden, who is familiar with the Guatemalan Indians, believes that the plant has been propagated by them because of its striking beauty, "for," he says, "the Guatemalan Indians are noted for their aesthetic temperament." Dr. Svenson of this Garden wisely remarks that perhaps both reasons, i.e. religious as well as aesthetic, are the causes of its continued popularity. "The Indians everywhere," he says, "like pretty flowers and so would decorate their shrines and churches with them."

THE GLORY OF THE POINSETTIA
LIES NOT IN ITS FLOWERS, BUT IN ITS BRACTS



This seems to be as close as we can come to the truth for, to quote again from Dr. Standley, "There are so many such plants, ornamental ones, long grown in tropical gardens but unknown anywhere in a wild state. The four-o'clock is a good instance, but it can take care of itself better than the poinsettia."

We earnestly hope that our readers who visit Mexico and the Central American States will bear this problem in mind and send any further information.

As Dr. Link explains elsewhere in this number of PLANTS & GARDENS, the flowers themselves are comparatively inconspicuous, the parts colored a brilliant crimson being in reality leaves or, rather, *bracts,* surrounding the flowers. A somewhat similar condition occurs in the flowers of our flowering dogwood (*Cornus florida*), where the four large white, petal-like structures are also bracts, surrounding a cluster of flowers at the center.

The flowers themselves are most peculiar. Without benefit of calyx or corolla, or with rudiments of these, they arise from inside a little cup, being attached at the base of the cup. The staminate and pistillate flowers are borne separately in this cup, and when fertilized, the pistillate flowers with their seeds are pushed forth from the cup by further growth of their stalks. Outside the cup is a conspicuous gland which secretes nectar, and because it is an "extrafloral" nectary, its function has caused some debate among botanists. However, even though the nectary is outside the flower it is no further removed from the flower's essential organs than are petals in a showy flower, and hence serves to attract insects as efficiently as brightly colored petals do.

The coloration of the leaves surrounding the flower in poinsettia is a phenomenon that is shared by closely related plants in the genus Euphorbia. The crown of thorns (*Euphorbia splendens*) with densely thorny branches and clusters of flowers, each with two scarlet rounded bracts, has long been a conspicuous occupant of the xerophytic house in the Garden conservatories. It is a native of Madagascar. *Euphorbia heterophylla,* known commonly as Joseph's coat, shows relationship by reason of the fact that its upper leaves and bracts have a deep red blotch at the base. This plant grows wild in the southern U. S. and the Bahamas, and "may be seen along waysides or in cultivated ground."

Another relative is snow-on-the-mountain (*Euphorbia marginata*), with the upper leaves bordered with a white margin or sometimes pure white, a common plant in gardens everywhere. Euphorbia is a genus which contains more than 600 species, very diverse in outward form, but, of course, showing their relationship in their flower structure, all with a very pronounced milky sap, ranging all the way from a common weed in our lawns, the milk purslane (*Euphorbia maculata*) to the marvelously beautiful poinsettia.

* * *

YOUR POINSETTIA FOR AND AFTER CHRISTMAS BLOOM

Conrad B. Link

THAT Christmas poinsettia can be made to flower again! The plant s usually in full bloom when it is received, and with care the red bracts will remain on the plant for several weeks. After flowering it requires a rest period. This may be brought on by less frequent watering, until the leaves begin to fall. Leaf fall usually begins at the lower part of the plant, until gradually all of the leaves have dropped. The red bracts are the last to go. When the leaves have fallen, the plant is ready to be stored; temperatures of 50 to 60° F. are best. No water is applied to the soil during this period of storage.

If the plant is not permitted to dry out and "rest," it will continue to grow, becoming too tall for use in the house. By taking advantage of this dormant period, the plant may be stored without harm and be easily kept as a room-size house plant.

In May, or when the danger of frost s past, the plant is ready to be primed nto growth. Do not delay too long, as plants held dormant until late June or July are weakened. The growth they will make is very poor, or they may not start at all. Cut the plant to within 6 or 8 inches of the soil and repot with fresh soil. See that the plant has good drainage by placing a piece of broken pot or a layer of fine gravel over the drainage hole. A good soil for poinsettias contains some organic matter or leaf mold. No fertilizer is needed unless the soil is of low fertility. After repotting, partially bury the pot outdoors in a sunny ocation in soil or cinders. Water the plant and keep the soil moist to encourage growth. A 2 to 4 inch layer of cinders below the pot will discourage the entrance of worms. During the summer the pot should be lifted or turned several times to prevent roots growing through the drainage hole into the soil below. If this is not done, many roots may develop outside the pot, causing a large number of leaves to wilt and drop from the plant when it is brought indoors in the fall. Above all, do not plant your poinsettia directly into the garden soil if you expect to take it indoors for Christmas bloom. Poinsettias do not transplant readily when in a growing condition, and they are likely to lose most of their leaves if the roots are disturbed.

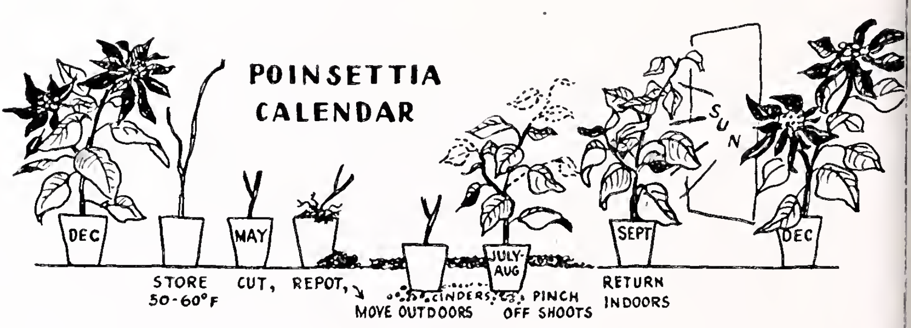
New growth appears in 1 to 2 weeks following transplanting (immediately after the rest period). Allow 2 to 3 shoots to develop on each plant and remove the others. Poinsettias grow rapidly during the summer; by removing a portion of the new growth it may help to prevent the plant from being too tall. This can be done by pinching off 4 to 6 inches from the tip of the shoot. Pinching will also induce branching. This should be done in late July or any time until mid-August. The plant will then have time to form new shoots before it is brought indoors. During the summer keep the plant watered so that it never wilts. With a good soil no fertilizers are necessary. If the leaves appear a very light yellow-green to yellow, it may indicate a need for nitrogen. This can be applied as nitrate of soda or ammonium sulfate. Dissolve 1 ounce of either of these materials in 2 gallons of water and apply in liquid form. A teaspoonful of a complete fertilizer such as Vigoro, Loma, or Agrico (any 4–12–4 or 5–10–5) to a

6 to 8 inch pot will be satisfactory. This should be applied on the surface of the soil. In most cases one does not want to encourage too rapid growth, for poinsettias can easily become too large for the house. Do not fertilize the plant after it has been brought into the house—with such treatment it is likely to form branches and leaves, but not flowers.

The plant should be taken into the house during September, before the nights become cool with danger of frost. In the house it should be placed in a sunny exposure with a temperature of at least 60° or 65° F. and should be protected from any sharp changes in temperature caused by drafts. The florist regulates time of flowering in poinsettias by maintaining uniform temperatures. Cooler temperatures will delay flowering. Drastic changes in temperature, or great fluctuations from a wet to a very dry soil in the pot, are conditions which may cause dropping of the foliage. Insufficient light and low humidity during the winter may also cause the same trouble. Poinsettias require as much light at a window as they can get; given proper light, favorable temperature, and kept well watered, color should begin to appear in the bracts in late November and be in fu flower by Christmas.

There are several varieties which ar grown by the florist for pot plants. Th red color is, of course, the most popula Some of the standard varieties are: Oakleaf, St. Louis, and Mrs. Paul Ecke. Th difference between these varieties i scarcely recognizable to the home ga dener. A word about the double poinsettia, Henrietta Ecke, a novelty variet and not often seen: it is made up of great number of colored bracts of a sizes with a few of the yellow flowe showing in between. It does not prese the regular pattern of color of the ord nary varieties. There are also sever pink, cream, and white variations of th red type. They are not showy, howeve and lack the brilliance of the red so muc desired at Christmas time. The whi offers an interesting contrast with th red, and goes well with it in decoration

Poinsettia is not the easiest of hous plants to grow, but is worth trying if on is willing to give it good care. Th showy flower head may not be as perfe as that obtainable from the florist. Ha ing grown and flowered under the watchful eye of its owner, however, it wi bring much enjoyment.



* * *

THE CHRISTMAS HOLLIES

How to grow them for pleasure and satisfaction

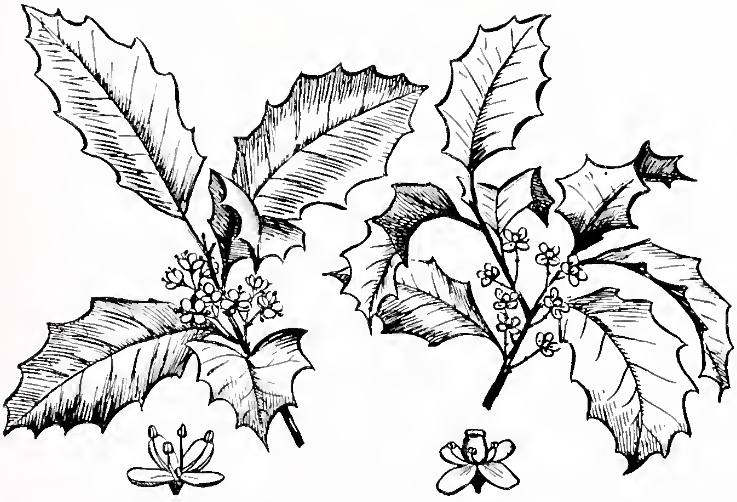
Conrad B. Link

"DECK the halls"—it's holly time at the old homestead. Holly has its share of recognition as a traditional Christmas plant, along with poinsettia, the Canada balsam, and mistletoe. In former days the woods had holly just for the picking, but now, after years of lawless destruction, the Christmas decorator must rely on his florist or grow his own. We are suggesting the latter.

A handsome, broadleaf evergreen, holly can be grown in Everyman's garden. Home-grown and well-cared-for holly can be pruned annually, yielding a plentiful supply of holiday decorations. The cultivated holly has more ornamental beauty than that garnered from the wilds. Holly for replanting, for a commercial crop, and for decorative uses makes a heavy demand on the nurseryman's supply; the home grower can supplement it in his own garden.

Species of Holly

Botanically speaking, holly belongs to the genus Ilex, which contains 300 different species. These are found native in both tropical and temperate regions. Most of them are not recognizable to the layman as holly: only a few have the familiar spiny leaves; all are not evergreen, some being deciduous; some have red berries (the kind we know), some have yellow, others black, and some none at all. This latter condition is common to all species of holly, because the male and female flowers of holly are borne on



POLLEN-BEARING FLOWERS "SEED-BEARING" FLOWERS

Holly. The pollen-bearing and "seed-bearing" flowers are borne on separate trees, commonly referred to as male and female plants. Berries are produced only after pollen from the male flowers has been carried to the female flowers by wind or insects. Use of a plant hormone spray applied to a female flower produces a normal appearing but seedless fruit

HOLIDAY DECORATIONS FROM YOUR OWN TREE

separate plants, and only the female plant bears the fruit.

In the north the only three species of holly used in Christmas decorations are the American Holly, English Holly, and Winterberry. The south has other red-fruited types to draw from, such as Yaupon (*Ilex vomitoria*) or Chinese Holly (*I. cornuta*). Occasionally other plants with holly-like foliage are used, which are not true hollies. Holly Flame-pea (*Chorizema ilicifolium*) is one of these; it is a tender greenhouse plant with small, holly-like leaves. From the southwest come a small gray-foliaged plant with red fruits, resembling holly, which is called Desert Holly (*Atriplex hymenelytra*). Desert Holly is seen only in a few florists' shops which carry the less common plants and decorative materials. Oregon Hollygrape (*Mahonia aquifolium*) is a broadleaf evergreen used as a low growing shrub. It has attractive dark green or bronzy leaves in the fall and winter. Although it differs some from holly, it is a useful material for Christmas decorations.

American Holly

To return to the northern hollies: American Holly (*Ilex opaca*) is a native tree, found from Massachusetts south to Florida, and west to Missouri and Texas. It is usually considered a small tree, though it may grow to 40 or 50 fee The American Holly will stand shade b will be tall and spindly if there is to much. The berries of American Holl vary in color from orange to red, and ar borne in clusters of one to several.

A considerable number of varieties o holly have been propagated and offere for sale by nurserymen. Most of the are tree forms, with but minor variations in habit of growth and color of th fruit. At least one variety has bee selected because of its low shrub hab of growth. As for hardiness: Cornma (3) reports the American Holly as bein hardy on Long Island, in the vicinity o New York City, and north into Rocklan and Westchester counties. Winter injur is not uncommon in other areas of th lower Hudson River Valley, along th fruit plain of Lake Erie, Niagara Rive and Lake Ontario. In other sections o the State it may be hardy in protecte places. Chadwick (1) reports that it hardy in Ohio except when planted i exposed situations. It is also hardy alon the Connecticut shore of Long Islan Sound.

English Holly

English Holly (*Ilex aquifolium*) is native of south and central Europe an Asia, and has long been cultivated i England. It differs from our America Holly only in the leaves, which are muc more spiny and very glossy. Englis Holly is a more beautiful plant than ou American Holly for decorative materia it is much less hardy, however, and ther fore cannot be grown as far north. Cor man (3) reports that it is not hardy i New York except in restricted areas i the vicinity of New York City. Th stand in the Brooklyn Botanic Garde gets along well where it is protected b other trees, although some killing back o burning of the leaves has occurred i severe winters. In Ohio, Chadwick (2 tells us that it is tender, and not hard north of Cincinnati. Its useful range limited to southeastern United States an some sections of Washington and Orego

The commercial orchards of those two States grow English Holly to supply the Christmas demand; there it is cultivated and cared for as a commercial crop. In addition to the green leaf type of English Holly, there are several varieties with less spiny leaves and those with a white or golden margin.

Winterberry

Winterberry (*Ilex verticillata*), a shrub growing 6 to 9 feet tall, is a deciduous species found from Canada south to Florida and west to Wisconsin and Missouri. It usually grows in the wet ground of bogs or swamps but may also be found on well drained soil. It drops its leaves in the fall, leaving exposed dark branches with masses of red berries. These remain on the branches and hold their bright red color until mid-winter. Although a most attractive ornamental, it is not often used as a shrub around the yard. It is adapted for use in informal or naturalized plantings.

Cultural Conditions

Growing and cultural conditions are about the same for all evergreen hollies. The remarks here will apply primarily to the American Holly but would also apply to the English Holly within its range of hardiness. Soil should be loose and well drained. In soils lacking humus, additions of peat, leaf mold, or well rotted manure are desirable as it is being prepared. While the holly will grow in slightly alkaline soils, it does best in a somewhat acid soil—so plant accordingly. Once the plants are established and growing, they should be fertilized with organic fertilizers such as cottonseed meal, although a complete fertilizer such as Vigoro will give good results. Rapid growth should not be encouraged because of the increased susceptibility to winter killing. Hence only small applications of fertilizer are recommended. As to transplanting, early spring is best, before growth begins. Nursery grown plants usually have a more compact root system than collected plants and are easier to transplant. As in all transplanting, the hole should be large enough to accommodate the root system without crowding or twisting. Nursery grown plants are dug and sold with a ball of soil; in filling in around the ball, good top soil should be used, and a saucer-like depression left at the surface to catch rain water. The plants should be well watered at the time of planting, and to conserve moisture it is a good plan to mulch the plant with leaves, peat, leaf mold, or straw. Such a mulch will be a help during that first winter in preventing deep freezing, and permitting the roots to get water. Evergreens lose water through their leaves all during the winter and, if they are unable to get it, they are subject to winter injury. Burning or dying of leaves may be caused by lack of water.

Pruning should be done at the time of transplanting, to remove unwanted branches and to shape the plant. Young holly plants often are rather scraggly for several years, but when they become 6 to 8 years old they begin to branch more freely and form a bushy, well-shaped plant. Older plants may be pruned by removing tips of the branches for decorations. With judicious pruning each year the plant will improve in its appearance.

The American Holly, an excellent plant grown as a single specimen, is better yet

NOT HAPHAZARD CUTTING FROM THE WILD!

in a group of several plants. Or it may be used in naturalistic plantings, but under such conditions it will not be the shapely tree that it is when standing alone. Since the plants are either male or female, nursery grown stock should be used. In groups of plants one male plant to 8 or 10 female plants is sufficient for pollination and fruiting. They should be close enough so that bees and other insects will carry the pollen to the female plants. If they are to be planted close together, put the male tree in the least conspicuous place, as it will never bear fruit. It is not possible to tell the sex of the plant until it is 6 to 10 years old, when flowering begins; if the plants are propagated by cuttings, they should be taken from plants of known sex. Consistent failure of a tree to have berries may come from its being a male or, if a female, from its isolation from a pollen bearing tree.

The latter difficulty can be overcome by the application of a recent discovery Spraying the open flowers of a female plant with a .005 per cent solution of naphthaleneacetic or other plant hormone sold under such names as App-L-Set Stop-drop, Niagara Stik, Fruitone, etc. will cause the plant to set fruit. The result will be nice red berries, seedless but otherwise normal.

REFERENCES.

1. CHADWICK, L. C. 1934. Key to ever green Ilex. Amer. Nurseryman. Mar 15.
2. CHADWICK, L. C. 1940. Ornamental evergreens. Ohio Agr. Ext. Service Bull. 113.
3. CORNMAN, J. F. 1941. Winter hardiness of some ornamental woody plants of New York State. N. Y. Agr. Exp Stat. Bull. 772.

LAWNS, WEEDS, AND 2-4-D

More about the plant hormone which is a selective weed-killer

George S. Avery, Jr.

IN the spring number of PLANTS & GARDENS there was an article on "Weed-killing Chemicals." It covered the field briefly and pointed with interest to the much talked of and then very new 2–4–D. We have now had two seasons' experience with this new selective weed-killer and want to report to our readers.

Demonstration Experiment

Scientific workers in many places are testing 2–4–D, together with other weed killers that promise to destroy weeds but not harm lawns, vegetables, or garden flowers. Our experiments here at the Brooklyn Botanic Garden have been confined thus far to lawn grasses and lawn weeds. We wanted to know what kinds of grasses were resistant to 2–4–D, and at the same time learn which lawn weeds 2–4–D could be counted upon to destroy With this objective, nine demonstration plots were seeded, each with a different kind of grass. In addition, two plots were planted with grass mixtures—eleven in all (figs. 1 and 2). Between each plot of grass, a narrow strip was planted with a common lawn weed, as shown in the accompanying pictures. When both grass and weeds were thriving, in mid-May, they were clipped with an ordinary lawn mower; mowings were continued at least once per week, all summer.

On June 9, a narrow tape line was used to mark off a three-foot-wide strip at the left, across all the grass plots and weed strips (fig. 2) and this three foot

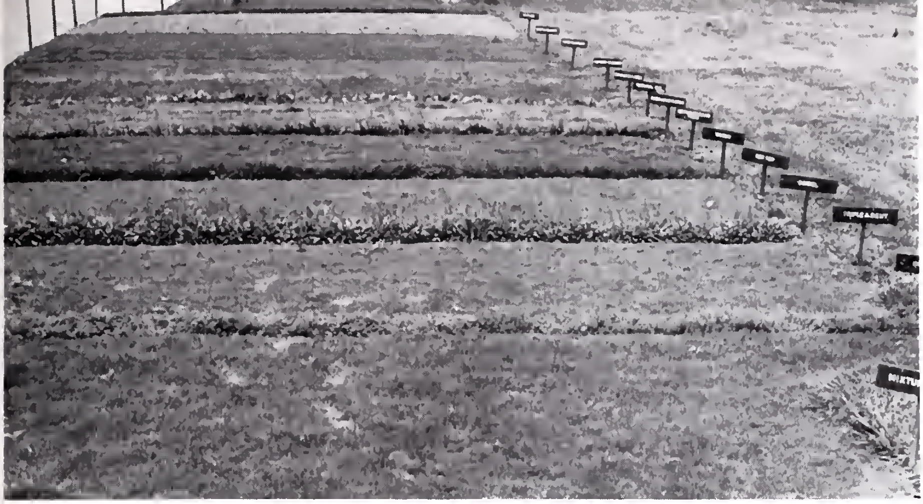


Fig. 1. Grass plots, with lawn weeds between. May, 1945. For planting plan, etc., see Fig. 2

strip was then sprayed with 2–4–D. A six-foot strip was marked off and sprayed on July 27, and a nine-foot strip on September 5. Thus, the first three-foot strip had three applications of 2–4–D, the second strip two applications, and the third one application. All sprays were put on early in the day, when the thermometer was at 70° F. or above.

Most Grasses Not Affected

The injury to the different grasses depended somewhat on the number of sprayings with 2–4–D, and was as follows:

Three sprayings: Triple A Bent showed the greatest injury, there being a number of large dead patches; Red Top had 6 inch to 1 foot diameter irregular patches; Rhode Island and Velvet Bent only slight injury. No visible harm was apparent in either of the two grass mixtures tested, nor in Kentucky Blue, Flawn, or Perennial Rye grass.

Two sprayings: Triple A Bent, dead patches, but not so extensive as the damage from three applications; Red Top, 3 to 5 inch irregular dead patches; no injury to the other grasses.

One spraying: No apparent injury to any of the several species tested.

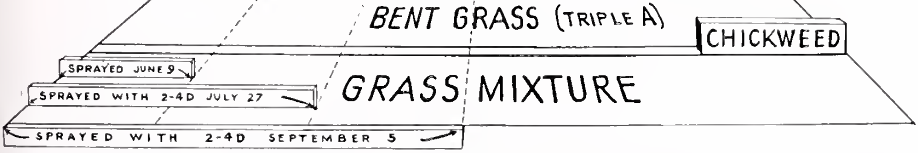


Fig. 2. Between each two grass plots a narrow strip was planted with a common lawn weed. Tape lines marked off three-foot strips across all grass plots and weeds. The strips were sprayed with 2–4–D on the dates indicated. The cooperation of the following seed firms made this experiment possible: Peter Henderson Company, New York; O. M. Scott Company, Marysville, Ohio; Stumpp & Walter, New York; F. H. Woodruff & Sons, Inc., Milford, Conn.

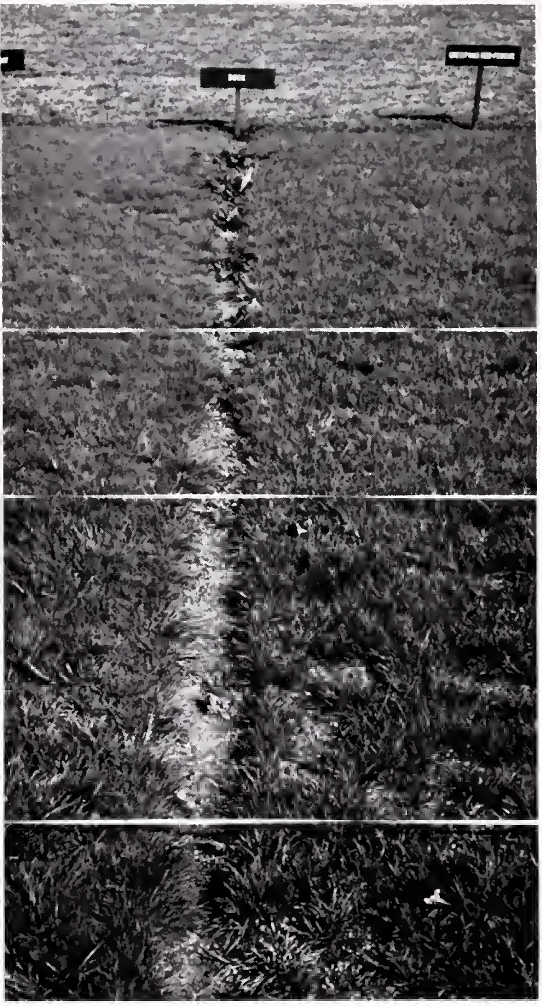


FIG. 3. Dock, growing between grass plots: Velvet Bent at the left, Creeping Red Fescue on the right. Dock was destroyed with only one application of 2–4–D. (Note absence of weeds in front of first tape)

Good Weed Kill

Completely destroyed with one spraying were dandelion, Canada thistle, dock, narrow- and broad-leaved plantain, and chickweed. In most instances the kill was complete within two weeks. Yarrow showed little or no injury even with three sprayings; knotweed required three applications for kill—the leaves of knotweed fell off with two applications, but stems were still alive. These results agree well with the work reported elsewhere by others. Aside from our small scale experiment of this summer, we find in the scientific literature that the following additional weeds are usually destroyed with one spraying: common ragweed, field mustard, shepherd's purse, lambsquarters, bindweed, jimson weed, lawn pennywort, round-leaved mallow, stinkweed, poison ivy and ivy-leaved speedwell.

Little Effect

In addition to knotweed and yarrow, mentioned above, crabgrass and stinging nettle are unaffected by 2–4–D. Common weeds to which 2–4–D will usually give a set-back are milkweed, daisy, and sheep sorrel.

Further Facts about 2–4–D, and How to Use It

Preparations available. Two nationally advertised preparations of 2–4–D (2, 4-dichlorophenoxyacetic acid) were available this past summer, Weedicide and Weedone. Sales were phenomenal from coast to coast, and it is a foregone conclusion that many new "brands" will appear this coming season.

Cautions. Directions furnished by the manufacturers give adequate information on concentrations to use, but there are a few facts about applying 2–4–D that ought to be emphasized:

1) Spray on warm days, when the temperature is about 70° F., or higher. At these temperatures plants are growing vigorously.
2) Spray in the early part of the day, so that there will be a long daylight period afterward.
3) Rinse the sprayer tank, hose, and nozzle in several changes of fresh water, for even a trace of 2–4–D may bring about some of the symptoms described below when used later with insecticides or fungicides.

How Plants Respond

Plants that are sensitive to 2-4-D become distorted within a few hours after spraying—stems bend and twist, leaves curl; and the young ones either stop growing or become deformed, change color, and soon die. Underground parts of affected plants stop growth and disntegrate. It is an odd sight to look down into a hole in the ground where a month before there was a robust tap root of a huge dandelion.

Effect on the Soil

There is no evidence, so far, to indicate that 2-4-D remains in the soil suppressing or in any other way affecting the early growth of plants which are sensitive o it.

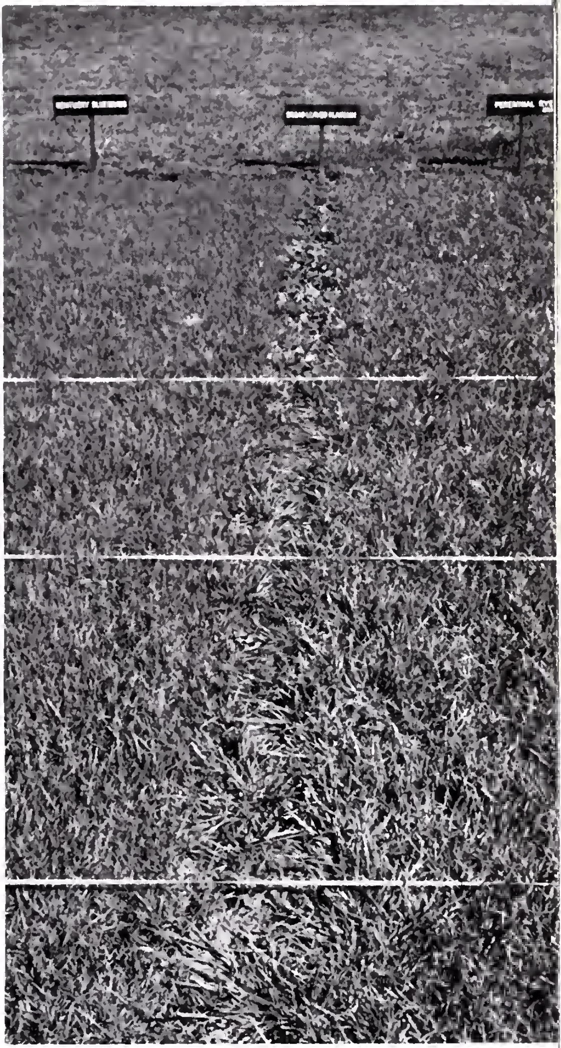
Evaluation

Researchers have finally turned out a synthetic plant hormone that is a plant killer if applied as a spray in the right concentrations. Moreover, it is selective n its action: some plants are destroyed, others not. This is a "natural" for killing the weeds without injuring the crop, but it isn't quite that simple. What can the average gardener and horticulturist expect from its use? One point should be clear at the outset: the selectiveness so far demonstrated does not make it possible to spray the garden at random and kill the weeds without harming the vegetables or flowers. Hence the garden is no place to try it, at least not for now. Tomatoes, a number of kinds of roses and a score of flower and vegetable favorites are destroyed by it. Lawns are different, and the experiments reported here show that the average lawn, grown from a grass seed mixture, is totally unharmed by 2-4-D, even if sprayed two or three times in a season.

An important advantage of 2-4-D over most other chemical weed-killers is its apparent harmlessness to man, beast, and soil. Even though the sprayer should be rinsed in several changes of water, after its use, there is no danger of corrosion of metal if it is not.

The future for selective weed-killing chemicals is bright. Where there are now but two (the other is closely related chemically to 2-4-D), there should be many in a few years, all with different affinities. Because of its importance to agriculture, selective weed-killer research activities should proceed swiftly, and the backyard gardener will be one of the beneficiaries.

Fig. 4. Broad-leaf plantain; Kentucky Bluegrass at left, Perennial Rye at right.



WE ARE SURE THAT EVERY READER WILL WELCOME THE FOLLOWING ARTICLES—INDICATIVE OF HORTICULTURAL TRENDS

RING OUT WILD BELLS

The right plant in the right place spells success with Campanulas

Richardson Wright

Reprinted from *House and Garden*, 1945

THE Bellflowers, like the Smiths, Joneses and Browns, are a very large family. Few of us gardeners will ever meet all of them, nor do we need to. Since most of them are easy to deal with, we can leave the untractable and finicking to the experts. Like the Smiths, Joneses and Browns, these campanulas are also of various heights—some sprawling and low of growth, others upstanding—which determine how we can use them to advantage in the garden and meet their preferences.

The colors they have to offer range from white to pink, from pale azure up through the lavenders to plain purple. Some, being biennials, we raise one year from seed to flower the next. Others, being perennials, have a relatively long life and when too crowded can be divided either by cutting the root or rooting side shoots in early spring. Since their seeds are invariably minute, they should be mixed with dry sand and sown on top of the soil in a seed pan or flat and watered from below. With few exceptions all campanulas do best in half shade. When not in flower the foliage is generally ornamental in itself.

The particular advantage of these bellflowers is that they come into bloom when the full tide of late spring abundance has begun to recede. Some start in mid-June, others later, and many, if the flowers are snipped off, will continue well into the fall.

Down the middle of a mixed border, where partial shade is available, use the more refined types—*C. persicifolia*, the Peachleaf Bellflower, 2′–3′ with spikes of large, cup-shaped flowers in dark or light blue and pure white. Telham Beauty is best for size and color of bloom; *C. lactiflora*, the Milky Bellflower, is a fleshy-rooted type that should be set in its permanent position when small as it doesn't do so well after being moved when adult. Its flowers are skim-milk blue-gray. Keep it in hand for it can become a nuisance. For odd corners try the Blue Bells of Scotland, *C. rotundifolia* var. Olympia, which will thrive in both sun and shade and is a long bloomer from early July on, with white or gray-blue flowers on fragile stems. It flourishes best in leafmold soil. Very showy are the Coventrybells, *C. trachelium*, reaching about 3′ and bearing blue or white flowers; but they have to be watched because they will run out less assertive plants. For backgrounds use the tallest—Chimney Bellflower, *C. pyramidalis*, which offers its purple or white flowers in late summer and autumn and raises its columns of blooms 5′–7′ high. An exception to this group of bellflowers that wil flourish for years, *pyramidalis* is a short-lived perennial best treated as a biennial It also makes a good pot plant.

The other taller types are for a woodsy site where they can range at will. *C americana*, a shade lover, bears its lavender stars on slender stems 2′–4′ high The old Rampion, or Creeping Bellflower *C. rapunculoides*, is a spreader and may become a pest but it is beautiful with its deeply scalloped lavender bells on erec stems. The Danesblood Bellflower, *C glomerata*, growing to 40″, is a close

Copyright 1945, Condé Nast Publications Inc., 420 Lexington Avenue, New York 17

McFarland photos, Chris Studios sketc

Chimney Bellflower, *Campanula pyramidalis*

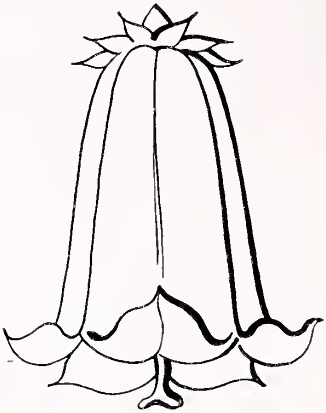
growing plant with distinctive tufted heads of bright violet. A two-footer is the Spurred Bellflower, *C. alliariaefolia,* with racemes of elongated white bells. As it is a spreader, give this also a half-wild setting where it cannot run out less dominant plants. *C. patula,* Rambling Bellflower, 2′–3′, is another for odd corners and not the border—hence its common name. Although a biennial it self-sows freely. To these taller types can be added *C. latifolia,* the Great Bellflower, 3′–4′, with large, long purple or dark blue bells. The variety *macrantha* is white.

Lower in height is *C. sarmatica,* perennial, 1′–2′, with pale blue nodding bells. *C. punctata,* the Spotted Bellflower, comes easily from seed. Its toothed leaves are broad and coarse. Its 2″ long flowers, solitary and nodding, are white spotted lavender inside. The plant grows to about 2′ high. Another two-footer is the Anatolian Bellflower, *C. macrostyla,* an annual with pale purple bells veined darker purple.

In the medium range come the biennial Canterbury Bells and Cup-and-Saucers, offering flowers in soft blue, rose pink and white. The single are better than the double. Raise from seed; transplant when 1″ high. They can be wintered over in a cold frame or under mulch and given their permanent places in spring.

Campanula abietina

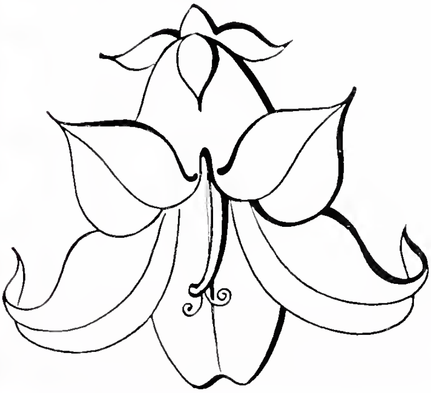
Canterbury Bells, *Campanula Medium*



Set them 6″ apart and, for fine specimens, give them fortnightly doses of weak manure water.

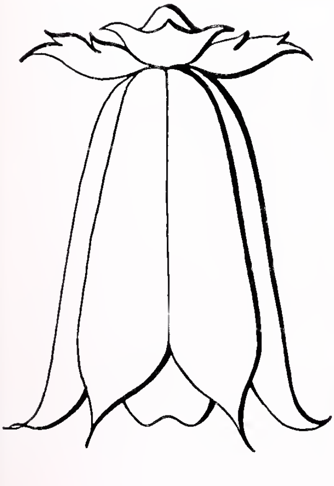
Bellflowers aplenty can ring up and down the miniature plains and crevices of the rock garden. Here only dwarf types, under 1′, are allowed. Half shade is their situation preference and, with three or four exceptions, a light sandy loam, well-drained, with plenty of limestone chips, their soil. They can be raised from seed. Some of them take a long time to germinate but that is no news to rock gardeners. Or, having lusty plants, they can be increased by division. The following will be enough for beginning alpinists.

Beginners usually start with the Carpathian Harebell, *C. carpatica,* which will thrive in any soil. Frothing over the rim of a rock or used as an edging to borders, it serves its purpose equally well. Grow it from seed (it grows easily) or pull the plants apart. Occasionally a white, open-faced cup appears among plants bearing only blue.



Great Bellflower, *Campanula latifolia*

Spotted Bellflower, *Campanula punctata*



Campanula garganica

Not so easy is the biennial *C. barbata,* the Bearded Bellflower. It demands good drainage but when it lifts its scalloped bells of porcelain blue to a foot high it is worth all the trouble it took.

Garganica is a little fellow, only 3″ tall and of compact, neat growth. Its heart-shaped leaves are toothed, but when the flowers come you can scarce see the foliage for the mass of flat, lavender-blue stars. There is also a white form.

Mirabilis, the Wonder Bellflower, is another biennial. Growing to 1′, its branching stems carry pale blue bells. *C. abietina,* a tufted rockery plant above 9″ high, bears light blue flowers on wiry stems in July and August.

The earliest to flower, coming in early June, is *C. muralis* (it used to stagger through life under the burden of *C. Portenschlagiana!*) not over 4″, with sturdy, neat, evergreen foliage spreading to a mat 6″ wide. It can be used to spill down the face of a wall, displaying its purple bells. It often blooms again in autumn.

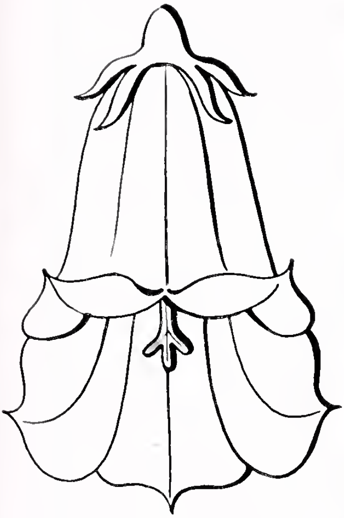
C. pulloides is one of the easiest. A creeper, its foliage soon covers quite a little area. From this in July and August rise profuse violet bluebells.

A very dwarf kind is the Single-nod Bellflower, *C. pusilla* (*C. caespitosa*) which, while it tolerates sun, insists on gritty, well-drained soil. Another spreader suitable for crevices, its white, pale or deep blue nodding bells apear in August. A variety, *C. Vanhouttei* has larger, shining blue pendant bells.

C. speciosa, the Bristly Bellflower, wants biennial treatment. The foliage consists of flat grayish rosettes but the purple bells are quite large, somewhat like those of Canterbury Bells.

Finally comes *C. Stansfieldii,* a bushy little plant that thrives best in partial shade and a well limed soil. From its pale green foliage rise dark blue bells.

Large or small, long-lived or short-lived, these bellflowers are all worth growing in the situations best suited for them. It is difficult to conceive a garden without a few kinds. It is also difficult, after growing these few, not to go on to other members of this large and lovely family.



Single-nod Bellflower, *Campanula pusilla*

* * *

TOO MANY LILACS

George M. Fisher

Condensed from *American Nurseryman*, Nov. 1, 1944

IF inventory were to be taken of the lilac stock on hand, lilac growers and gardeners might realize that they are in a dilemma over varieties, or have fallen into a lilac rut the past few years. Are there not far too many varieties of the common lilac in cultivation?

There have been numerous lists of recommended lilacs from various sources during the past decade, in a logical attempt to eliminate some of the similar varieties and clear up this bewilderment. A real contribution to the cause was the recent report, "Lilacs for America," edited by John C. Wister. In this list the number of rated varieties of lilac (*Syringa vulgaris*) has been reduced to 100.

Many of the newly bred lilac seedlings originated in the past few years have failed to show much improvement over earlier, accepted varieties. We even find some named varieties developed by nurseries in this country which, except by the closest scrutiny, are impossible to distinguish from lilacs developed in other countries or from some other nursery in this country. For seedlings of the common lilac, the limits of beauty and out-

Jeanne d'Arc

standing traits seem to have been reached, and among other things the exquisite fragrance of the old-fashioned lilac seems to have been largely lost through intensive crossbreeding, and the size of the bloom and color have certainly improved little in the latest varieties.

There is apparently little opportunity for further improvement in the hardiness of lilacs. The hybrids, as well as most of the introduced species lilacs, are hardy from lower Canada to the upper tier of the southern states. The species lilacs as a group, especially the forms of closest relationship to the old-fashioned purple lilac, are considered by landscape men to be among our most permanent shrubs. They will thrive under conditions of considerable neglect and are unexcelled as a shrub to thrive under adverse city conditions. The horticultural varieties, of the group of so-called French lilacs, are a little more exacting in their growth requirements and respond well to increased care and attention in the garden.

The bulk of the good varieties exchanged and sold in the trade should be reduced in number as much as possible. It is suggested that certain nurseries ideally located and organized may well become specialized growers of lilacs. These few specialists could confine their operations to supplying the rest of the trade with prime-grown plants of the best sizes for landscaping, sales and growing on. Nurserymen should welcome such available stock, as French lilacs are a slower-growing type of shrub, especially when grown on their own roots, and require more attention and care than the average small nurseryman can afford to give to grow the top-grade plants.

By the average gardener or the casual observer of lilacs, just a few criteria need to be considered in the selection of a good variety. Of course, the color groups must maintain their identity, and individual tastes as to double- or single-flowering preferences must be considered. Full attention should be given, too, to use of the lilac as a border or garden landscaping shrub. In the past, many superior ornamental values of certain lilacs have been overlooked in the quest for flowering characteristics, and the trends now are to recognize the landscaping values.

By process of elimination, the number of lilacs of superior and proved merit in flowering and desirable landscaping qualities can be sifted down to about two dozen varieties and still provide for all possibilities and variations of individual tastes. It has long been the writer's intention to provide a creditable list of a few select horticultural varieties of the common lilac. With the help of several other collaborators, annual observations have been made for the past five years. The result is the following selected list of twenty "best" lilacs.

Twenty Desirable Horticultural Varieties of Common Lilac:

White to Cream White

- Double. Mme. Lemoine, 1890. Pure white, erect, tall-growing.
- Double. Edith Cavell, 1916. Creamy-white, heavy clusters, pale sulphur buds.
- Double. Mme. Casimir Perier, 1894. Free-blooming, low habit, good for forcing and cutting.
- Single. Vestale, 1910. Heavy blooms, pure white, long panicles.
- Single. Jan Van Tol, 1916.

Pink to Rosy

- Double. Belle de Nancy, 1891. Large flowers, satiny rose blend.
- Double. Katharine Havemeyer, 1922. Dependable, good foliage.
- Single. Macrostachya, before 1844. Free-flowering, clear pink, turning white.
- Single. Lucie Baltet, before 1888. Low-growing, immense, salmon-pink in bud.

Lucie Baltet

Marechal Lannes

Lavender to Purple

- Double. Marechal Lannes, 1910. Bluish-violet. Large flowers, semidouble.
- Double. President Grevy, 1886. Clear soft blue, immense panicles.
- Double. Victor Lemoine, 1906.. Mauve-lilac, rather late, enormous clusters.
- Single. Cavour, 1910. Slate-blue, upright clusters, large blooms.
- Single. President Lincoln, 1916. Wedgewood-blue, early, bluest single lilac.
- Single. Jacques Callot. 1876. Large silvery-mauve blooms.

Reddish to Deep Purple

- Double. Charles Joly, 1896. Purple-red, silvery reverse, medium height.
- Double. Adelaide Dunbar, 1916. Dark crimson, semidouble, darkest double lilac.
- Single. Congo. 1896. Dark wine-red, immense flowers, splendid grower.
- Single. Reaumur, 1904. Dark carmine, fine bloomer.
- Single. Ludwig Spaeth, 1883. Dark reddish-purple, profuse bloomer, one of best.

HYBRID VEGETABLES

What they are and how they're produced

Donald F. Jones and
Amanda Quackenbush

Condensed from *Flower Grower,* April 1945

THE story of hybrid vegetables is comparatively new. About twenty years ago the first commercial sweet corn hybrid was produced, and because of the discovery of hybrid corn, corn growers are making millions of dollars annually. The idea of better vegetables through hybridization has spread until today we have hybrid varieties of squash, onions, cucumbers and tomatoes on the market. The advantage of a hybrid is that the crossing of two distinct strains of plants usually produces more vigorous offspring.

For successful results a breeder must carefully select two unlike parent inbreds with the good qualities expected to appear in the hybrid offspring, the inbreds being the offspring of self-pollinated parents.

Hybrid Corn

Back in 1908 Dr. George H. Shull, biologist at the Carnegie Institute in Cold Spring Harbor, Long Island, crossed uniform inbred strains of corn according to this principle and produced more vigorous plants which gave much higher yields than the parents. These early hybrids, however, were not practical commercially; the procedure was too expensive, and the hybrid seed was small and poorly matured. In making a single cross from two small and unproductive inbred parents Dr. Shull gained in yield but lost in seed quality.

Then in 1917 the profitable production of hybrid corn could commence, for in that year the Connecticut Agricultural Experiment Station invented the *doubl* *cross* method of producing hybrid seed Two high-yielding single-cross hybrid were crossed resulting in a new hybri with large well-matured and easily produced seeds. Significance lies in the fac that last year over 90 per cent of th corn grown in the Corn Belt was double crossed hybrid.

Seed production for all this acreag necessarily became a "big business" undertaking, and seedsmen devote thousands of acres to growing hybrid seeds adapte to various sections of the country.

In well isolated fields, alternating "crossing rows" of two different inbreds ar planted so that the silks of the seed-producing flowers of one inbred will appea at the right time to be fertilized by polle from the other or pollen-bearing inbred To insure cross fertilization, the tassels on the seed-producing rows are pulle out before any pollen is shed. The result is that each kernel developed is a hybrid. The pollen rows are not used for commercial seed.

The mature seed ears are harvested, dried in seed corn driers to the right moisture content, shelled, cleaned, and graded for size and shape. From this seed grow vigorous, almost perfect stands of plants.

Seed cannot be saved and planted the following year for hybrid vigor is not permanent. The yield usually falls off about 20 per cent and uniformity of ears is lost. So newly crossed seed must be planted each year.

Squash

In 1938 the second hybrid vegetable, Yankee Hybrid summer squash made its appearance at the Connecticut Experiment Station. This vigorous hybrid, made from a cross between Early Prolific Straightneck and a Station inbred strain,

Copyright 1945, Williams Press, Inc., 99–129 North Broadway, Albany, N. Y.

Conn. Agr. Exp. Sta. photo

College girls pollinated tomato blossoms by hand all summer long in this 5-acre field to produce seed of Fordhook Hybrid Tomato

Connecticut Inbred C10, ripened a week ahead of standard varieties and produced a greater amount of larger fruit during he early growing season.

The mechanics of producing a hybrid squash are somewhat similar to those used in making hybrid corn. The male (pollen-producing) and female (fruit-producing) flowers of all cucurbits (gourd or squash family) grow on the same plant. To produce a hybrid squash, alternate rows of the two inbred strains or varieties that are to be the parents are planted. All the male flowers are picked off of one variety, which becomes the female parent.

Commercial seed producers depend upon bees to transfer the pollen from the neighboring rows, which still retain their male flowers, to the receptive portion of the flowers of the female parent. There the pollen germinates and sends tubes down through the pistil to fertilize the egg cells in the ovules at the base of the female flower, and the hybrid squash results.

Cucumbers

W. Atlee Burpee Co. has recently announced the availability of the first commercially produced hybrid cucumber, claiming high resistance to bacterial wilt and to mildews, extreme vigor, long life and abundant fruit.

Crossing of this vegetable is usually done in the greenhouse since otherwise it would be difficult to remove all male flowers from one parent. Pollination is done by hand, pollen of the male parent being brushed upon flowers of the female parent.

Tomatoes

Burpee is also offering for sale the seed of the first hybrid tomato to be put on the market in this country, the Fordhook. It is exceptionally vigorous and gives a very heavy yield.

Conn. Agr. Exp. Sta. photo

To prepare tomato flowers for crossing, the stamens of seed parents are removed with tweezers daily to prevent self pollination

Tomatoes are one of the most difficult hybrids to produce. The reason for this is that the plant produces a "perfect flower"—one which contains both male and female parts. Plants of this type will ordinarily self-pollinate. In order to make a hybrid, the anthers, which contain the pollen, must be removed by hand from the flowers of the female before the pollen has a chance to shed and fertilize its own flower. Next the seed producer must make the transfer of pollen by hand in a tedious, specialized operation. However tomatoes have so many seeds that each pollination results in several hundred. Each plant grown from these seeds can be multiplied by rooting cuttings, and thus the harvest of seed greatly increased.

Onions

The first and only marketed hybrid onion, the California Red variety, was produced by H. A. Jones of the U. S. Department of Agriculture.

Hybrid onions are produced by a process somewhat different from that of other hybrid vegetables. The onion is a perfect-flowered plant, naturally self- or cross-fertilized by insects. However, there is found a hereditary variation of this plant, in which the male portion of the flower is sterile and produces no pollen. This type of plant will set seed readily when cross-pollinated with another variety. When isolated from pollen of other varieties this plant produces no seeds but propagates vegetatively by producing little bulblets which fall to the ground and root.

This sterile variation is made use of in producing hybrids. Rows of ordinary seed-producing onions are alternated with female parent rows of the sterile type. Crossing proceeds naturally since the female parent produces no pollen.

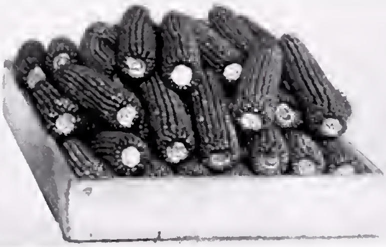
According to the California Agricultural Experiment Station Bulletin, 1938, about 1926 the study of onion sterility was undertaken, and a male sterile strain of Italian Red was isolated. In 1934 its resistance to downy mildew, the scourge of California onions was discovered. Italian Red Pedigree, 13–53, thus is mildew resistant as well as sterile. The California Station introduced an improved strain of California Early Red, U. C. No. L in 1935. It was originally developed from a Red Italian variety.

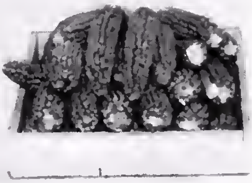
By taking advantage of these sterility factors in plants, many other hybrid vegetables may be produced by this method. Cabbage, cauliflower, beets, muskmelons, and watermelons are some that may be next in line.

Hybrid vegetables are here to stay. And with plant breeders working upon improvements and new types of hybrids, the future may bring better vegetables than the grower has ever known before.

→

Hybrid vigor in corn. Yield from rows of uniform length. Left and right—Two strains inbred for several generations. Center—The first generation plants of a cross between the inbred strains. The rate of yield per acre was: Strain at left, 20 bu.; at right, 32 bu.; in center (hybrid), 115 bu.





Conn. Agr. Exp. Sta. photos.

HYBRID POPCORN

Arthur M. Brunson and
Glenn M. Smith

Condensed from *Journal of the American Society of Agronomy,* March 1945

It is difficult to understand why a popcorn crop should be put in the nonessential or semi-luxury category in wartime, when in reality it is one of the most efficient sources of human food in terms of usable calories produced per acre. Few foods can be stored so long so cheaply or are so easily processed for consumption.

The popularity of popcorn has been increasing, especially during the past two or three years. Why then, is so little as 0.1 per cent of the total corn acreage of the country devoted to it (50 to 100 thousand acres per year), and why have plant breeders somewhat neglected the possibilities of improving popcorn? One reason is the overshadowing importance of field corn in our agricultural economy.

The producer of popcorn is interested in the yield and in the ability of the crop to stand well until harvest, and in its resistance to disease and insects. Hybrids that give a higher yield than regular open-pollinated popcorn have been produced, but there is still far to go in improving other characteristics.

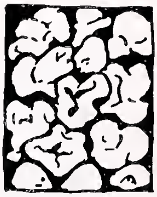
The popcorn consumer, whether commercial vendor or home popper, is concerned with other qualities, such as tenderness, hulls, flavor, kernel shape, and color, when he buys popcorn. Popping expansion refers to the volume of popped corn obtained from a given amount of unpopped corn. An expansion of 18–20 is fair, 21–26 good, 27 or above, excellent. Grocery store popcorn is usually 20 or below. The Purdue University Agricultural Experiment Station has designed a machine which provides a standard means of measuring expansion.

Tenderness often accompanies high expansion. Hulls are objectionable, but some varieties of "hulless" popcorn have hulls so thin they are hardly perceptible. The range of flavors is wide, from none at all to sweet, to disagreeable, but by selection of inbred lines it is possible to improve undesirable flavors.

Popped kernels are of two general shapes: the mushroom type which puffs up, and the butterfly type which turns inside out when it explodes. Mushroom kernels are characteristic of a South American variety and hybrids originating from it. These mushroom-kernel types sometimes have a flecking of deep yellow on the outside, the amount differing according to the varieties or hybrids. Other kernel colors range from yellow to white, the former being cream-colored when popped.

ORDINARY

HYBRID



ORDINARY

HYBRID
29% HIGHER
POPPING EXPANSION

Previous Work and Current Investigations

The Minnesota Agricultural Experiment Station introduced the first commercial hybrid popcorn (Minhybrid 250) in 1935. A small-kerneled and small-eared variety of white hulless type, it gives a 16 per cent higher yield and 29 per cent higher popping expansion than the open-pollinated hulless variety with which it was compared. Unfortunately it is adaptable only to the northern edge of the Corn Belt.

In Manhattan, Kansas, in 1925, J. G. Willier, then with the Bureau of Plant Industry, succeeded in improving yield and standing ability of yellow popcorn, but quality was very mediocre. However, the Kansas Agricultural Experiment Station, after four years of inbreeding of Supergold, a high-expansion yellow pearl variety, and an especially good strain of South American, has produced some very promising hybrids. Severe droughts in 1930–36 in Kansas retarded the work, but in Lafayette, Indiana, the Purdue University Experiment Station and the U. S. Dept. of Agriculture have continued hybridizing the same material. Commercial production is now based on four choice Supergold strains, designated by the plant breeders as Sg16, Sg18, Sg30A, and Sg32, and one South American strain, SA24. The hybrids between these strains are all single crosses or 3-way crosses. Eventually the more economical double crosses will supplant these.

The Purdue Experiment Station, in all their tests and performance trials (acre yield, popping expansion, etc.) have found that by far the best yields have been obtained in hybrids between Supergold and South American parents.

Dealers in popcorn have been quick to appreciate superior popability, and many have been willing to pay extra for better popping corn. Despite the fact that seed production of the Purdue hybrids has approximately trebled every year, the demand has outrun the supply each year to date.

The principal types of corn. All were known to the American Indians. Flint, Dent, Pod, Sweet (below), Flour (above), Pop (two varieties)

Gottscho-Schleisner ph

Wint

A SPECIAL MESSAGE

Of Course We Are Pleased

with the "fan-mail" letters many readers have sent, praising our presentation of educational articles in inviting, easy-to-read, understandable English—with pictures galore.

To us, this means that PLANTS & GARDENS will not be cast aside; that it will become a standard reference for horticultural problems.

◆

BROOKLYN BOTANIC GARDEN RECORD

PLANTS
&
GARDENS

Spring, 1945

BROOKLYN BOTANI

PLA
&
GARI

Summe

Layout of the Small Place
—
What's in a Name
—
Shrubs for Special Uses
—
The Living Tree
—
Weed Killing Chemicals
—
Why House Plants Fail

VOL. 1 NEW SERIES NO.

BROOKLYN BOTANI

PLA
&
GARI

Autum

Layout of the Small Place
—
Grass—and Lawns
—
House Plants in Summer
—
Water Gardens
—
Insect Pests and Diseases of Plants

VOL. 1 NEW SERIES NO.

BROOKLYN BOTANI

PLA
&
GARI

Winter

Layout of the Small Place
—
Autumn Coloration
—
Chrysanthemums
—
Plant Hormones and Cuttings
—
Seed Germination

VOL. 1 NEW SERIES NO. 1

Selected Articles
on
Horticulture and Gardening
—
A City Garden
—
Poinsettia and Holly

VOL. 1 NEW SERIES NO.

With This In Mind, we are offering a practical binder, pictured below, and suggest that each volume—four issues, index included for easy reference—be permanently kept as a guide on your horticultural shelf.

1 **Binder** - - - -	**$1.00**
2 **Binders** - - - -	**$1.50**

Postpaid

Use Order Blank on Opposite Side of This Sheet

REMINDER

HERE IS YOUR RENEWAL

form if your Subscription was for 1945 only
(for new or gift subscription too!)

PLANTS & GARDENS

Subscription Rates

1 Year	$2.00
2 Years	$3.00

Renewal / Please send } PLANTS & GARDENS for ☐ 1 year ☐ 2 years

Check for $.................... enclosed.

Name..

Address...

....

Name..

Address...

....

A SUBSCRIPTION TO PLANTS & GARDENS IS A PERFECT GIFT FOR YOUR GARDEN-MINDED FRIENDS

A neat Binder for the year's PLANTS & GARDENS. Keep your copies together.

1 Binder	$1.00
2 Binders	$1.50

Check for $.................... enclosed.

BROOKLYN BOTANIC GARDEN
1000 Washington Avenue, Brooklyn 25, N. Y.

Gottscho-Schleisner photo

rtraits

DO VEGETABLES CROSS POLLINATE?

Gordon Morrison

Condensed from the *Flower Grower,*
May 1945

ALL gardeners, beginners and old-timers alike, watch the spring garden anxiously for the first flower and fruit. Many, however, are but dimly aware of the process involved in the setting of fruit, and differences in methods of pollination in many kinds of plants.

The flower contains the sexual apparatus of the plant. In some plants, such as asparagus, the female flowers are on one plant and the male flowers on another. In other plants, such as squashes, cucumbers, melons and corn, the male and female organs are in separate flowers on the same plant. And in still other plants, such as tomato, each flower is botanically perfect, that is, it contains both male and female organs. In all instances, the female flower must receive pollen if it is to mature and set seed.

In squashes, cucumbers, melons, and related plants, male flowers develop earlier than female flowers and are more numerous, often in the ratio of 12 to 1. Exceptions are the modern hybrids: Early Prolific Straightneck squash and Straight-8 cucumber, which have a high ratio of female to male flowers, hence are more productive of fruit. The male flowers wither soon after pollen production, whereas female flowers have swollen bases, the ovaries, which enlarge to become fruit after fertilization. Most of these cucumber flowers that disappear in great numbers leaving no trace of fruit are no doubt the earlier male flowers.

Bees are important in vine crop gardens. Normally they carry pollen from male to the female flowers, but long periods of cold, wet weather may interfere with their pollination work and the yield of fruit will suffer accordingly.

Melons and Cucumbers

There is no basis for the belief that cucumbers and melons will cross, to the detriment of the melons. Nor will melo cross-pollinate with squashes or pumpkin Cucumbers and melons are separate sp cies and have never been crossed succes fully, even in plant breeding laboratorie Poor-flavored melons are more likely result of pre-ripe picking.

Vegetables with Perfect Flowers

Tomato, pepper, lettuce, peas, bean cabbage, broccoli, radish, and many oth of our food and ornamental plants be perfect or complete flowers. Each pe fect flower includes within its structu both male and female sexual parts. Son vegetables, notably cabbage, radishes an onions, bear perfect flowers that are ope to pollination by bees, while other kind notably garden peas, bear flowers th are invariably self-pollinated.

Cross Breeding in the Garden

Sometimes home gardeners try to sav seed from their own gardens, but suc seed usually proves disappointing afte planting. Most vegetables of home ga dens are subjected to natural crossin with other varieties in all the neighbo hood gardens through insect and win pollination with the result that charac teristics of the crossed varieties are mixe in the seed crop. The vegetables them selves are fine for table use, for the edib part is not affected.

Commercial Seed Growing

A few dollars invested in tested seed is a worth while investment for the hom gardens. Quality and uniformity in vege tables depend upon intelligent applicatio of knowledge about inbreeding and cros breeding. Commercial seed growers wh produce seed in quantity are able to pre serve the uniformity and excellence i hybrid vegetables originally achieved b plant breeding stations.

Copyright 1945, Williams Press, Inc., 99–129 North Broadway, Albany, N. Y.

U. S. D. A. photo.

Conditions for small seedlings remain favorable in sphagnum for long periods: A, flat of seedlings 12 months old; B, plants transplanted from this flat 2 months previously

SOW YOUR SEEDS ON SPHAGNUM MOSS

V. T. Stoutemyer, Albert W. Close and Claude Hope

Condensed from *Flower Grower*, March 1945, and from Leaflet No. 243, U. S. Department of Agriculture, November 1944

GARDENERS should be aware of the many advantages to be gained by the use of sphagnum moss instead of soil as a seeding medium. Here is a simple, practically fool-proof method for germinating the seed of nearly any kind of plant, common or choice rarity. A minimum of equipment and attention are required for this method, and it prevents attack by the fatal damping-off disease without the use of seed treatments or sterilization of soil. A number of prominent plant pathologists have recently voiced approval.

Sphagnum is a moss which is found in bogs in many parts of the country, although most of the commercial supply is collected from Wisconsin and New Jersey. We have tried to discover other germinating mediums which equal sphagnum in all respects, but the nearest substitute we have found is vermiculite, an insulating material for houses, which is suitable but does not protect against damping off.

The popularity of sphagnum for seed germination is gradually increasing. Plant breeders find its use means avoided losses in valuable lines of seedlings. A

Copyright 1945, Williams Press, Inc., 99–129 North Broadway, Albany, N. Y.

few sphagnum-grown plants, notably pansy and vegetable plants, were offered for sale last spring.

Availability and Preparation

The baled dried sphagnum moss can ordinarily be obtained from seed dealers and mail order firms, and small quantities are often used in packing material in shipments of nursery stock. Unfortunately small packages or bags of prepared shredded sphagnum do not seem to be available commercially, but usable material can be prepared from crude sphagnum or collected from near-by bogs and used in a living condition.

Sticks and foreign materials must be removed from the living moss which is then spread out to dry slightly, and shredded by rubbing through wire screen having 3 meshes to the inch. Long and stringy crude sphagnum is not satisfactory for seed germination, but shreddin can be easily done by hand or by machine. Shred large quantities of dr sphagnum in a hammer mill having 1 inch openings.

Preparation of the Seed Bed

Any kind of seed flat or cold frame i satisfactory. Drainage should be goo and decaying flats should not be use since they may contain organisms whic destroy sphagnum.

The flat can either be entirely fille with sphagnum and firmed down so tha the surface is one half inch below th edge of the flat, or an inch thick layer o sphagnum may be deposited over a foundation layer of soil, sand, or sand an peat. Water thoroughly and allow several minutes for drainage. And becaus a smooth compact surface favors growt of green algae, it is advisable to apply

U. S. D. A. photo.

Plants grown in flat of sphagnum for shipment may be separated with enough sphagnum adhering to protect roots in transit ne eighth inch thick layer of moss, and prinkle it lightly.

Use of Nutrient Solutions

Mineral nutrients are not necessary to btain satisfactory plants, but the addiion of dilute nutrient solutions before or fter sowing and germination of seeds vill probably produce more vigorous rowth. Five or six teaspoonfuls of rdinary, low-analysis mixed garden ferilizers, such as a 4–12–4 or a 5–8–6, or teaspoonfuls of a 12–12–6, or 1 teapoonful each of potassium nitrate (salteter) and superphosphate in a gallon of vater are suggested. Discard unsoluble esidue.

No chemical treatments are needed for ontrolling damping-off, although treatients to control other seed-borne disases may be applied as usual. Seedlings rown in sphagnum, even though inocuated with damping-off fungi, have reiained free from attack. The reason has iot yet been fully ascertained.

Sowing the Seed

Seeds may be sown in rows or broadast on the surface. Except for larger eed, they are usually not covered. The urface is then watered gently and the flat s covered tightly with glass or with rames covered with a glass substitute iaterial in order to reduce evaporation nd keep the sphagnum moist. Often no iore water is needed until after seeds erminate.

As to lighting, a compromise between ight and shade can be attained by coverng flats with enough shading material, uch as paper, burlap, or cheesecloth, to educe, but not exclude light until the eedlings begin to grow. By this proedure light preferences of seeds can be gnored. Following germination, admit as much light as seedlings can endure and increase ventilation.

Be sure to keep the sphagnum wet. Experiments have shown that overwatering is virtually impossible, but water must be applied from the top, not by subirrigation.

Retention of Seedlings

Occasional applications of dilute fertilizer solution, as mentioned above, may be given to increase growth of seedlings. On the other hand, if plants are desired for later use, the withholding of the nutrient solution will stop growth. Many kinds of plants can be kept in a retarded condition in sphagnum for a long time. Seedlings have been kept in flats as long as a year without permanent injury. Upon transplanting and addition of nutrients, seedlings develop into normal, healthy plants.

Transplanting

Seedlings are easily pricked off from the flats at early or late stages of growth. Disturbance to root systems is ordinarily less than from soil transplantations.

Growing and Shipping Plants

Sphagnum is used in packing plants that are to be shipped since it is easily handled, easily kept moist, is light in weight and thus easily adapted for travel. Balls of sphagnum do not shatter as do balls of soil after removal from pots.

In conclusion, then, the growing of plants in sphagnum offers numerous advantages. It is simple, cheap, and applicable to all sizes and kinds of seeds, whether the grower is interested in vegetables, annuals, herbaceous perennials, or woody plants such as azaleas. In experiments, plants grown in sphagnum have been fully as good as or better than those grown in soil prior to setting out.

* * *

IS SOIL TESTING THE ANSWER?

Alex Laurie

From *American Rose Magazine*,
July–August, 1945

THE popular soil test has its merits. It cannot be depended upon, however, as the complete guide for the treatment of plant ills. Such a test pictures only the acidity or alkalinity of soil, the supply of nutrients, and the amount in available form, and fails to give information on water supply, drainage, soil aeration, organic matter content, temperature, and other physical factors.

Soil tests are considered to give a fairly accurate indication of soil acidity. In the case of roses, they fail. We assume, for instance, that roses will grow best in the narrow range of slightly acid soils (pH 6.0–6.5) but actual experience shows that they often do well in extremely acid (pH 4.5) to alkaline (pH 7.5–8) soils. A soil test of acidity alone in this case would indicate a change, yet in practice it would be unnecessary.

In general, soil tests are designed to indicate the capacity of the soil to supply nutrients and to estimate the amount in an *available* form. "Available" is stressed because we are not concerned with the total amounts of the minerals present, since they may not all be available to the plant. A total analysis also gives only a part of the story. The physical factors mentioned above are another part.

The value of a soil test often hinges upon proper interpretation. It takes experience to diagnose correctly and to determine what fertilizer mixture to use. Some soil testing kits presume to advise, on the basis of a color variation, not only the amount but the exact formula of fertilizer to apply. This color method analysis alone is not reliable.

Since most soils contain the other elements necessary for the growth of roses, tests for nitrates, phosphates, potassium and calcium are ordinarily sufficient. Some soil testing systems (the Spurway and the Morgan) indicate the available nutrients in parts per million of soil, so that a knowledge of the most favorable amount for the growth of roses is needed.

The nitrate requirement of roses varies with the season. For example, the nitrate requirement varies from 25 to 75 p.p.m. (parts per million). In late spring, during the period of rapid growth, nitrates can be high (50 to 75 p.p.m.), but in the hot summer, as growth slows down, amounts over 25 p.p.m might be actually injurious. As the plants ripen in the fall a slight rise—not enough to cause excessive vegetative growth—might be beneficial. To supply nitrogen, use ammonium sulfate, sodium nitrate, or calcium nitrate, at the rate of 1 pound to 100 square feet. Organic carriers of nitrogen as dried blood or tankage are used at the rate of 3 to 4 pounds to 100 square feet.

An adequate phosphorus requirement of roses is 2½ to 5 parts per million in the soil at all times. Applications of super-phosphate or bonemeal will maintain this amount when applied at the rate of 5 to 10 pounds per 100 square feet. These materials must be cultivated or spaded into the soil, since phosphorus penetration is very slow.

A soil test for potassium (potash) should show at least 20 to 40 p.p.m. available potash, although greater amounts are not injurious. Muriate of potash (potassium chloride) 1 pound to 100 square feet or wood ashes 4 to 6 pounds to 100 square feet will take care of this need.

Calcium is essential both as it affects the soil acidity and structure and the growth of the plant. For roses, a soil should contain 150 p.p.m. If the soil is but slightly acid, application of 2 pounds of calcium sulfate to 100 square feet will maintain the proper level. Lime is used if the soil is moderately or extremely acid.

All in all, by indicating what is lacking, soil tests can tell how to avoid wasteful and useless fertilizing. To be certain that your first interpretation of the test is right it might be a good idea to check with your experiment station. If their terminology is in pounds per acre, this is 8 times the figures for parts per million.

Soil testing serves as a guide in the nutritional problem, but it cannot solve the ills which may befall roses from other causes. He who prepares his soil well physically and uses chemical soil tests wisely, will have certain assurance of better growth.

* * *

BALANCED MANURING

W. G. Ogg and Hugh Nicol

Condensed from the *Scottish Journal of Agriculture*, January, 1945

WHAT is behind the rivalry between the old standby, manure, and inorganic (mineral) fertilizers?* Is fertilizer actually harmful, is manure the complete answer to soil fertility?

Ever since their introduction into horticultural practice, inorganic fertilizers have not been fully accepted. The opposition is led by proponents of fallacies, who object to their use for various reasons: they poison the soil, bring about erosion, injure the quality of crops, lower disease resistance of plants, and even harm farm animals. Disregarding the fact that farming in itself is an offense against Nature, the opponents decry the use of "artificial" fertilizers and advocate complete reliance upon the products of the farm, such as green manure, composts, and animal manure. So far there is no scientific evidence verifying their beliefs.

At the Rothamsted Experimental Station, experimentation in soils and plant nutrition has been in progress for a century. Although not designed on modern lines, these experiments have yielded valuable information about the relative values of organic manures and inorganic fertilizers in enriching the soil. Other institutions throughout the world have had similar programs of research; the conclusions presented below are, therefore, the results of widespread scientific investigation.

The Alleged Harmful Effects of Fertilizers

There is no evidence that artificial fertilizers are harmful to the chemical and physical condition of the soil. Even abnormally heavy application of fertilizers for a hundred years has had no detrimental effect on soil. The use of sulfate of ammonia is, of course, an exception, since in hastening the removal of lime, it leads to soil acidity. This evil, however, has its correction—liming.

Soil erosion may occur on land heavily fertilized. Rather than being a case of *post hoc ergo propter hoc*, the erosion may stem from poor farm practices as, for example, the lack of crop rotation in many agricultural areas. Organic matter in the soil helps to prevent erosion but that is scarcely an argument against the use of fertilizers. A soil with a complete supply of available nutrients will produce bigger crops possessing more root yardage and hence more potential organic matter.

---

* The term "fertilizer," as employed by the authors of this article, refers to inorganic materials; "manure" to organic products, whether plant or animal. (Ed.)

The claim that fertilizers adversely affect soil bacteria has no scientific backing. The chief role of these organisms is to break down organic matter into forms of nutrient usable by plant life—nutrient similar to that provided by fertilizers! More organisms are present in manured soils, of course, because they are concerned with processes of decomposition, but there is no evidence that the application of fertilizers injures them. Neither have fertilizers been found to reduce the earthworm population of ordinary soil.

As for plants being more susceptible to insect, fungus, and virus attacks because they were grown on fertilized soil—experiments at Rothamsted point the other way. The use of fertilizer appears to be beneficial to plants in such cases. Addition of organic material may actually increase some types of root-disease fungi and may reduce others, depending upon the character of the parasite and the kind of plant. Since the degree of a plant's susceptibility to such fungus attacks is mainly a nitrogen effect, it is immaterial whether the source of nitrogen is manure or fertilizer.

Do fertilizers have an injurious effect upon the composition and quality of the produce? The growth of good, healthy crops depends on so many other factors (moisture, temperature, and sunshine) that a crop failure cannot be blamed wholly on fertilizer. In reference to quality, no significant difference has bee found in the vitamin content of manur as compared to fertilized crops.

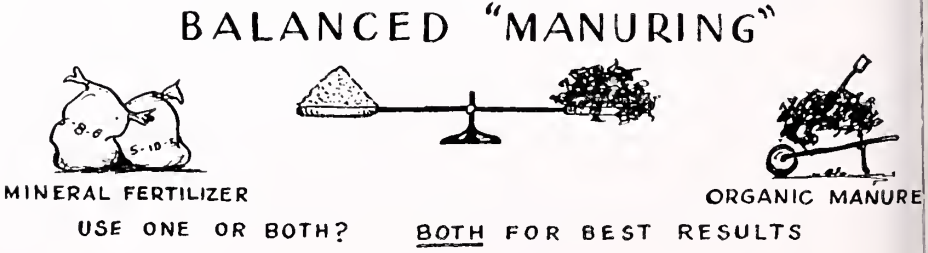
Manure receives favor in many circl because it is used by market gardeners producing "quality crops." Actually, th use manure to supplement the sandy, ba ren soil such crops are commonly grow in. Because the nutrients in manure a liberated slowly, there is no fear of ove supply. It is not the use, but the misu of mineral fertilizers that may be dange ous to crops. Nutritionally it makes n difference whether nutrients are applie as fertilizers or as manures.

Effects on Animals

As already pointed out, there is n evidence that the use of fertilizers is i any way connected with disease susce tibility in farm animals. When chron soil deficiencies are remedied, it is mor likely that the animals eating crops raise on that soil will become more, not les healthy. A little of some normally ab sent element, such as cobalt, sprinkle over an area deficient in cobalt will pr vent disease stemming from lack of th element. An excess quantity of certai poisonous elements (molybdenum an selenium, for example) in the soil natur ally makes plants growing there toxic t animals, but manuring will not cure suc a situation.

Balanced Manuring

The controversy over manures versu mineral fertilizers arises from confusio of thought and failure to understand th



problem. Manures have their place. They improve the physical condition of the soil and usually contain a wide range of nutrients, perhaps all that are necessary for plant growth. Often, however, the nutrients are badly balanced, and it is necessary to supplement them with fertilizers. The recent discoveries of vitamins and other organic growth substances suggest that manure may owe special virtues to such substances, but investigations to date have revealed no such information.

Fertilizers, on the other hand, contain the necessary nutrients in a concentrated form, a form easily applied and quickly available to plants. With an intelligent use of the mixtures on the market, a perfect balance can be provided. Where decomposable organic matter is essential, a balance can be attained by using manure plus fertilizer.* "Soil-less gardening" is an excellent example of the efficiency of mineral fertilizers in growing plants without the benefit of organic matter.

The amount of manure available is insufficient for the needs of present day agriculture, and restriction of manuring would undoubtedly bring about a great increase in the cost of food, leading possibly to world famine. In any case, it would be worth while to supplement farm organic matter with town wastes: garbage and sewage material. Modern methods of collection and transport make this readily obtainable. Composts are valuable also; they make good use of residual vegetation. Even with all this organic manure, however, crops would require still more plant food. Thus, the "artificial" (mineral) fertilizers also have their place.

Unfounded beliefs, giving rise to the idea that fertilizers are harmful, should be discarded. Both manure and fertilizers have their uses, and they should be considered as complements rather than as rivals.

---

* The commercial preparation, Adco, hastens the decomposition of garden left-overs, leaves, vines, etc., into organic fertilizer. Mineral-enriched fertilizer is reported to yield twice the dry weight of tomatoes that compost alone yields.

TOO MANY FRUITS SPOIL THE CROP

George L. Slate

Condensed from *The Home Garden*, June 1945

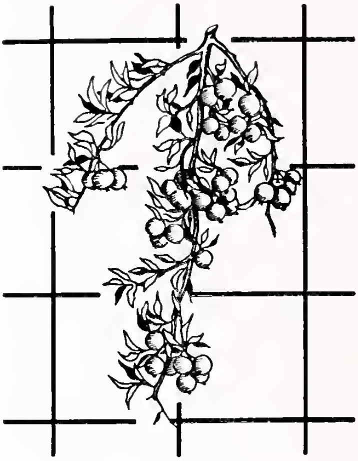
THIS discussion is set forth in order to acquaint fruit growers with the benefits to be gained by thinning newly-set fruits. Thinning will not only increase the size of the remaining fruits but often will brighten their color and improve their flavor. Proper spacing greatly reduces brown rot of stone fruits and discourages the codling moth, for fruits are more easily sprayed and dry faster when they do not touch.

The tree as well as the fruit benefits from thinning. Sometimes branches are not strong enough to support a full load of fruit, and thinning saves breakage casualties. Trees which have overborne lack vigor with which to defy a severe winter.

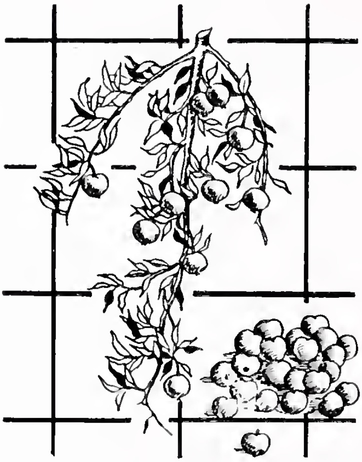
A good time to thin is when the fruits are about 1 inch in diameter, after the "June drop" which occurs because so many fruits setting at once are too much

Copyright 1945, The American Garden Guild Inc., 444 Madison Avenue, New York 22

Amount to Thin Apples



Typical overloaded branch before thinning. Squares are 12″ along all sides



The same branch thinned to average 8″ interval. Pile shows fruits removed

for the tree to stand. Inferior and poorly set fruits fall of their own accord.

A minimum of 30 leaves per apple i required—to consider apple trees. Som varieties need more; McIntosh, Cortland and Greening require less. And leave must be near the fruit, not on anothe branch, as there is no transfer of food from one branch to another. Henc heavily laden branches should be thinned even though nearby branches have littl or no fruit.

To thin, first shake the branches, then remove the injured fruits, and finally, i necessary, twist off enough healthy fruits to leave one to a cluster spaced 6 to 8 inches apart.

Pears, except perhaps the Seckel, are not thinned in the East, but peaches are another story. If the set is heavy, the peaches, if left, will be small, pale, and nearly worthless. The trees should be pruned, of course, but thinning is still essential. Peaches are thinned soon after the June drop and before the pit hardens It is pit formation which most exhausts the trees. Early varieties are thinned first—about 50 per cent of the fruits being removed, leaving the fruit spaced 6 to 8 inches apart; later varieties should be thinned 30 to 40 per cent with a spacing of about 4 inches between the mature fruits. More fruits can be left toward the outside of the tree where foliage is better exposed to sunshine.

Japanese plums and the Gage varieties must be thinned. The plums are plucked out when 3/4 inch in diameter to leave a spacing of 3 to 4 inches apart. Italian prune and the Damsons are not thinned Apricots, too, are thinned so that fruits will not touch each other when ripe.

* * *

Official photos U. S. A. A. F.

The beginning of the garden on hot, dry, windswept Ascension Island. Ditches are to be filled with gravel and nutrient solutions applied

UNCLE SAM, GARDENER IN GRAVEL

Captain Richard C. Davids

ondensed from *Better Homes and Gardens,* August 1945—with additional pictures

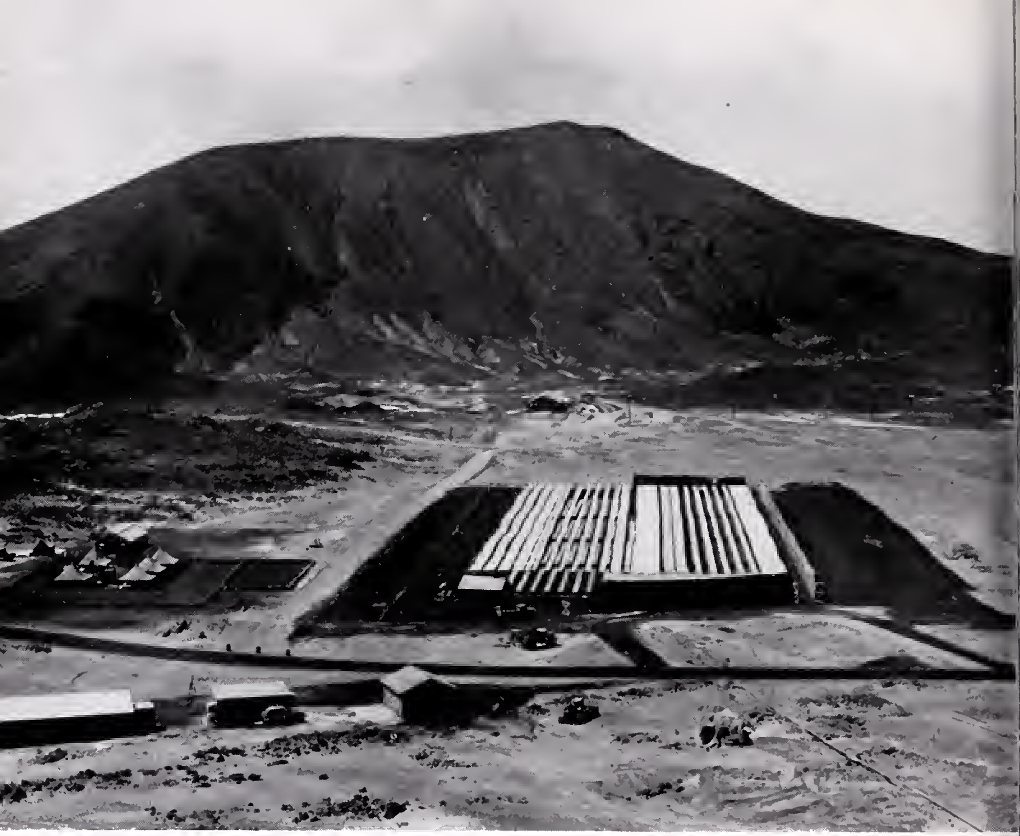
The Army remembers the early New Guinea campaign where men developed that listlessness and fatigue common to the tropics, and how this vanished with a change from processed rations to fresh vegetables and meat. Theoretically the standard rations are complete. If deficiency symptoms develop, it's only after months without change. But strangely, the fact that the ration becomes monotonous may be the result of actual dietary lacks.

HALFWAY round the world on hot, dry, Ascension Island, so rocky and sterile that it cannot support a pigweed, soldiers have been growing fresh, flavorful vegetables.

Cut off by thousands of miles from fresh food sources, the Army Air Force has a program to feed its soldiers tomatoes, lettuce, radishes, peppers, and cucumbers as fine as any ever grown in your garden.

They are growing plants where Nature never intended, in coral gravel or volcanic pebbles devoid of earth, and fed on a liquid diet of minerals required for rapid

Copyright 1945, Meredith Publishing Company, 1714 Locust Street, Des Moines 3, Iowa.



General view of hydroponics site

Chemicals are mixed in crude laboratories

growth. This soilless culture of plant is called hydroponics.

Soilless gardening is not new. But th story of how the Army helped release i from the obscurity of laboratories an mustered it into practical use is a story o translating science into action.

Ascension Island, home of the Arm Air Force's first vegetable factory, is jus off the equator, about midway betwee South America and Africa—a jagged volcanic island. Thirteen hundred mile of ocean travel was too far to carry vegetables, and air transport was needed desperately for other kinds of supplies.

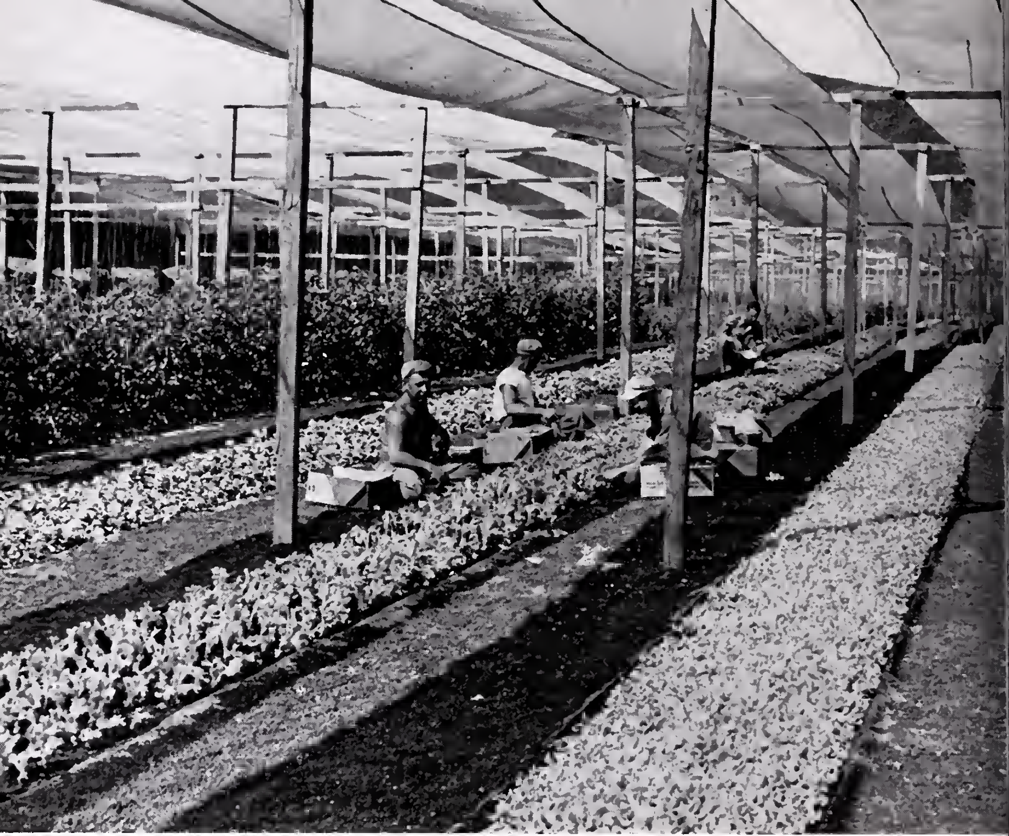
Several months ago a hydroponics uni

vas set up. One hundred beds 400 feet ong by 3 feet wide were dug and the ottoms coated with asphalt to prevent vater loss, since no rain falls for stretches as long as 7 months. The beds vere filled with sifted volcanic gravel. On the side hill above were built two water tanks where chemicals were dissolved and the solution permitted to flow lown into the beds. The water, all distilled from the sea, had to be more jealously guarded than minerals. Cloth strips were staked across the top of the beds to ward off the intense subequatorial sun, and windbreaks were erected to protect the gardens from the prevailing 12–20 mile per hour southeasterly winds.

A common practice in gardening is to sprout seeds in seed beds of sand, then transplant into main beds. This is pre-

View of one of the hydroponics beds, lined with asphalt

G. I.'s pick leaf lettuce grown in chemically nourished gravel beds under a sun shield of netting



View of the main hydroponics beds. Note the use of over-head netting to provide shade for the tender young plants

cisely what the soldiers did at Ascension. But a problem was immediately encountered—pests. The night after the germinating flats were planted the seeds mysteriously disappeared. It was discovered that hungry mice had been the culprits.

When the seeds germinated the mice lost interest and armies of land crabs, crickets, and other animals and insects swarmed over the growing plants, but all were finally conquered by sticks, stones, and insecticides. No weeds invaded the gardens.

Another problem was the faculty of the volcanic pebbles for absorbing heat. When the temperature was 90 degrees three feet above the bed, it would be 156 degrees a half inch beneath the surface. It was discovered that a mulch would cut the temperature in half and preve excessive evaporation of water. Win breaks were used to protect the plan generally.

Normally, before cucumbers and t matoes will fruit, they must be pollinate The job ordinarily is done by bees a other insects. An island like Ascensio however, is so barren that there are n bees. But scientists had the answer- fruit-stimulating hormones. Current e periments indicate that a cloud of the hormones can be spread around the plan by an aerosol bomb, thus saturating large area. The resulting fatherless t matoes were seedless, or nearly so, a firm, with clear unbroken skins. Late a hive of bees was imported.

The soilless gardeners were not troubled with blossom end rot, a disease th ias plagued tomato growers for years. The reason for this lusty health was the careful mixture and proper concentration of all the chemical elements necessary for normal growth.

Growth regulation is another part of the magic of chemically controlled gardening. Plants can be held at a standstill for two or three weeks by putting them on a starvation diet, and this growth control is important for keeping the production beds in constant year-round use. As soon as one crop is exhausted it is replaced at once with new plants.

Chemicals necessary to the nutrient solution are divided into the "majors" or macro-elements like nitrogen, phosphorus, and potassium, and the "trace" or micro-elements like magnesium and boron. It has been discovered that some kinds of plants, without boron, are weak, apathetic, and with absolutely no get up and grow to them. Add no more than a single spoonful in 10,000 gallons of water and they snap right up into active growth. Lack of sufficient iron causes leaves and stems to turn yellow and die. Too little manganese causes failure of a plant to produce the green matter of the leaves.

Following the success at Ascension, soilless culture gardens have been set up at many other locations. In the tropics, where soil may become infected with organisms causing human disease, hydroponics is as vitally necessary as on Ascension Island.

Picking cucumbers from the hydroponics beds

Hydroponics garden

Just what are the commercial possibilities of soilless gardening? On a cost basis it probably can't yet compete with truck gardening during the productive season. Initial costs are high, but once the plant is operating it continues with slight cost and little hard manual labor. A commercial plant in southern Florida is said to be producing 2,000 bushels of tomatoes to the acre during off seasons.

Probably in flower culture hydroponics will find a more immediate future. Many florists are already growing carnations at a much lower cost than in soil. Roses so grown, produced one and one-hal more flowers per plant than soil-grown and on stems so long that a man can' reach the blooms.

The long-range results of these vegetable factories, now flourishing on desolate reaches of sand and waste, towards freeing frontier country from nutritional diseases, are hard to guess. But in immediate results, the U. S. Army Air Forces have shown that soilless gardening can pay off.

* * *

EMBRYO CULTURE OF IRIS SEED

L. F. Randolph

ondensed from the *Amer. Iris Soc. Bull.,*
May, 1945

ONE of the problems encountered in the growing and cross-breeding of arden varieties of bearded iris is the inconsistency and reluctance with which the seeds germinate. After maturing, seeds ormally undergo a period of dormancy uring which they will not germinate. The period of dormancy for iris seed ersists from several months to many ears. In the mild southern climate of the United States some of the seeds harested in August and planted by Novemer will germinate in February or March. Farther north a month or two more are equired.

The proportion of seed that germinates the first year is extremely variable and usually small. Seed that does not germinate the first spring may do so the next year, or the next, or in 5 to 15 years. First year germinations of new crosses have been as low as 10 per cent, although the average in my garden from 1938 to 1942 was 35 per cent.

Seed Dormancy

Breaking the dormancy of iris seed by artificial means is not easy. Conditions which cause other seeds to germinate have little or no effect upon iris seeds which, even after many years, will retain their ability to germinate (viability) but fail to do so under ordinary conditions. Attempts to improve the germination of iris seed, aside from the embryo culture technique, have not been very successful. Seeds were chipped, chilled before planting, or planted immediately after harvest. Others were subjected to near-freezing temperatures for several weeks, the end of the seed chipped to remove the cap of tissue covering the root portion of the embryo, chipped and subjected to increased oxygen pressure, or soaked in running water. The average rate of germination after treatments never exceeded 64 per cent. A combination treatment of soaking chipped, chilled seeds in running water was the most effective treatment.

It has been demonstrated that iris seed dormancy is not caused by the dormant condition of the embryo itself, for embryos removed experimentally from the seed and cultured on a sterile nutrient medium began to grow almost immediately and soon became normal, healthy seedlings.*

The story of embryo culture technique, as this procedure of removing embryos is called, began in Germany about 40 years ago. Today it is a standard procedure for obtaining seedlings that are difficult or impossible to germinate.

Embryo Culture Technique

The experiments of Hannig (1900), Dietrich and Laibach (1925), and Werkmeister (1936) are German landmarks in the development of this technique. In this country Tukey was the first to employ it on an extensive scale, in the production of sweet cherry seedlings, about 1932. The method is useful in the study of various kinds of botanical problems, as well as of value to the plant breeder and the analyzer of the causes of dormancy in seeds.

Randolph and Cox described a procedure for culturing iris embryos in 1943.

---

* Apparently there is some growth inhibiting substance present in the stored food in the seed which retards growth of the embryo. Embryos did not germinate and grow well unless the food storage tissue was completely detached. As mentioned above, attempts at ending the seed dormancy, which were really attempts to destroy this inhibiting substance, did not succeed. Randolph and Cox, *Proc. Amer. Soc. Hort. Science,* **43**: 299, 1943.

Author photos.

The embryo is removed from the seed with a dissecting needle which is sterile

This has since been modified into a simpler and more reliable method, requiring a minimum of spécial apparatus or facilities. Germicidal solutions are used in connection with removing embryos from seed instead of special sterile chambers or a special transfer room. And a method of growing the seedling plants has now been perfected, which practically eliminates losses from diseases such as damping-off.

The embryo culture technique involves simply the transfer of the embryos from the seed to culture bottles containing sterile nutrient agar.*

At favorable temperatures the embr soons begins to enlarge and within 2 or weeks grows into a seedling with w developed roots and leaves. It is th transplanted to soil and grown to matu ity in the usual manner. The essent steps are few in number and relative easy to perform, although care must exercised. The following directions a of interest to those who wish to utili the embryo culture technique for the pr duction of iris seedlings.

The Work Room

Any well lighted room reasonably fr

---

*Agar is a clear jelly-like medium, used for culturing the embryos, and is prepared by heating seven grams of agar with one liter of distilled water (ordinary tap water may be used if it is not heavily laden with chemical purificants) until it is completely dispersed. To this is added 20 grams of sucrose (table sugar) and 5 milliliters of each of the stock solutions A and B. The amount of agar recommended is just sufficient to cause the culture solution, when cooled to room temperature, to form a solid medium having the consistency of soft gelatine. The hot mixture is distributed to culture bottles and after being sterilized and allowed to cool is ready for use.

A convenient type of culture bottle is approximately one ounce in size, wide-mouthed, screw capped, such as those manufactured by the Armstrong Cork Co., Lancaster, Pa. Black phenol formaldehyde plastic caps are the most satisfactory after first being boiled in a strong soap solution to prevent leaching of substances injurious to embryos duri steam sterilization.

The bottles should be filled with the l culture solution to a depth of approximat one-half inch. A liter of solution is suffici for approximately 125 one-ounce bottles. T culture solution should not be allowed come in contact with the neck of the bottl if it does, contaminations may result. Aft the solution has been placed in the bottl they are capped and then sterilized in autoclave or pressure cooker at fifteen poun pressure for 20 minutes. The caps shou not be screwed down tightly until t bottles have been sterilized and permitt to cool. After removal from the sterilizi the bottles should be protected from air cu rents with a covering of paper to preve excessive condensation of water on the inn surface of the bottles as they cool. Th may be stored for several weeks or long until ready for use if they are protect from dust and excessive evaporation of t agar medium.

An excised embryo is transferred to a sterile culture bottle

rom bacteria and mold spores is suitable or the transfer of the embryos from the eed to culture bottles. The possibility of ontamination by air-borne spores may be educed by spraying the prospective work oom with a one per cent water solution f carbolic acid to which several drops of wetting agent (such as turgitol) have een added for each pint of solution.

Preparation of Nutrient Culture Medium

This is a more or less technical laboratory problem, and is included in the footnote at the bottom of the page for those with the scientific urge, who will want to know.*

Removing Embryo from the Seed

The surface of the dry seed should be sterilized for one to two hours in a concentrated water solution of calcium hypochlorite, to each pint of which a few drops of a wetting agent such as turgitol have been added. The commercial bleaching agent, Chlorox, diluted with approximately an equal volume of water, also may be used for sterilizing the seed.

---

* It is convenient to combine most of the arious ingredients of the culture medium n two concentrated stock solutions from which the desired quantity of nutrient soluion may be prepared as needed.

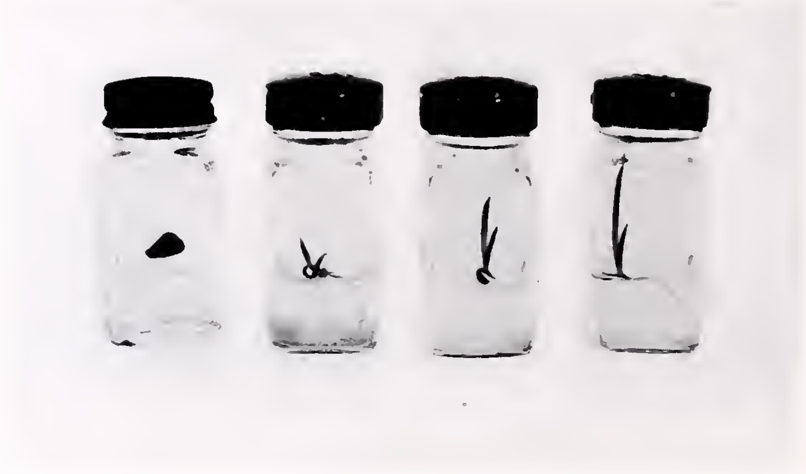
SOLUTION A

Calcium Nitrate—$Ca(NO_3)_2 \cdot 4H_2O$	23.6 gms.
Potassium Nitrate—KNO_3	8.5 gms.
Potassium Chloride—KCl	6.5 gms.
Distilled Water	500 ml.

SOLUTION B

Ferrous Sulfate—$FeSO_4 \cdot 7H_2O$	0.2 gm.
Calgon—$(NaPO_3)_n$	1.0 gms.
Magnesium Sulfate—$MgSO_4 \cdot 7H_2O$	3.6 gms.
Distilled Water	500 ml.

The salts comprising solution A are readily soluble in water and form a solution that is stable at ordinary temperatures. Solution B is prepared by dissolving the ferrous sulfate and magnesium sulfate in 250 milliliters of distilled water. If either the Calgon or ferrous sulfate is added to an aqueous solution of the other salt an insoluble precipitate is formed. Solution B ordinarily is stable at room temperature but as a precaution against the formation of an insoluble precipitate of iron phosphate it should be stored in a refrigerator at near-freezing temperatures. Chemicals of chemically pure grade should be used in making up these solutions. With the exception of Calgon, which is the trade name of a sodium hexametaphosphate product manufactured by Calgon, Inc., Pittsburgh, Pa., they are readily obtainable from chemical supply houses. Calgon forms a soluble complex with both iron and calcium which remains in solution indefinitely and produces a clear nutrient medium ordinarily used for similar purposes. It eliminates the difficulty of retaining in solution the small amount of iron necessary for optimum growth.



Culture bottles contain a sterile ungerminated iris seed (left) and seedlings aged six to t
days, developed from the embryos which have been excised

After they have been surface sterilized the seeds are soaked in sterile or boiled water, changing the water daily for 3 to 5 days to soften the food storage tissues of the seed and facilitate the removal of the embryo. Freshly harvested seeds removed from ripe pods before they begin to open do not need to be sterilized and ordinarily require no preliminary soaking in water. If the dry seeds are not surface sterilized, and are soaked in ordinary tap water, bacterial contamination is likely to occur. Iris embryos rarely survive more than a few days on culture media if contaminating bacteria are present.

The soaked seeds are then immersed in a solution of 50 per cent alcohol in preparation for the removal of the embryos. As the embryos are being removed the razor blade used in opening the seed and the fingers of the operator that come in contact with the seed should be dipped frequently in the alcohol solution, the germicidal properties of which are effective in reducing contamination. Immersion in 50 per cent alcohol for longer than three to four hours is injurious to the embryos of intact seed, and the alcohol should not be permitted to come in direct contact with the embryos for more th a few moments.

Removal of the embryo is achieved the following manner. A longitudin cut is made in the seed directly towar but not quite to, the central region occ pied by the embryo. In making the c it should be started near the scar whe the seed was attached to the pod, and e tended backward and around the seed the opposite side. The seed may then separated into approximately equal halv exposing the embryo, as indicated in t figure which shows the embryo being r moved with a bent dissecting needle. B fore removing the embryo from the se the needle is dipped in 95 per cent alcoh flamed, with a single passage throug the flame of an alcohol lamp, then dipp in a hexylresorcinol solution, S.T. 3 diluted with an equal volume of wate This antiseptic solution, prepared Sharp and Dohme, Philadelphia, Pa., a commonly available at drug stores, is n harmful to the iris embryos and as aid in handling them has proved to be effective germicide. Also, the embry adhere to the moist needle more readi than they do to a dry needle. The u f 95 per cent alcohol and flaming to terilize the needle, in addition to the ise of the hexylresorcinol solution, is hiefly precautionary.

In transferring the embryos to the culure bottle, it is advisable to hold the ottle in a horizontal position to prevent he entrance of air-borne germs while he cap is removed. After the embryos ave been placed on the surface of the utrient agar in the bottle the cap should e screwed down firmly, but not too tightly, as an exchange of air within the bottle is essential for the growth of the seedling. Ordinarily two seedlings are placed in each bottle. If one becomes diseased or a contamination develops on the surface of the agar the unaffected embryo may be transferred to a fresh culture bottle.

Growing the Embryo into a Seedling Plant

The embryos are cultured first in darkness at a temperature of 28 to 30 degrees Centigrade (82 to 86 degrees Fahrenheit) for 3 to 5 days, and then transferred to weak daylight or artificial light equivalent in intensity to the light from a north window, for an additional 3 to 5 days. Thereafter, the culture bottles containing the young seedlings should be transferred to the stronger light of a shaded greenhouse or cold frame from which direct sunlight is excluded and in which a temperature ranging from about 65 to 85 degrees F. is maintained. Within two or three weeks after the embryos are planted in the bottles the young seedlings ordinarily have well developed roots and at least two or three seedling leaves. They are then ready to be transplanted from the bottles to soil.

After the young seedlings have been transferred from the culture bottles to soil, either in flats or in seedling beds, they should be protected from sunlight and rapid evaporation for several days. A layer of sifted sphagnum peat approxi-

Pot culture of iris seedlings from excised embryos. Seedlings grown in the greenhouse over winter from seed harvested in August and September may bloom the following spring after being transplanted to the garden.

mately an inch in depth is distributed over the surface of the soil in which the seedlings are to be planted, to conserve moisture and inhibit the growth of disease-producing organisms. This is important, and neither soil nor fertilizer should be mixed with this surface layer of peat, or it may no longer protect the seedlings. After the seedlings have become established in the soil they may be handled in the same manner as ordinary seedlings that have been grown directly from seed.

Iris seedlings produced from excised embryos make excellent growth under greenhouse conditions during the winter months at Ithaca, N.Y. In this latitude night temperatures of 60 to 65 degrees and day temperatures of 65 to 75 degrees F. are most favorable for normal seedling growth, and supplemental lighting is not required, either to increase the intensity of daylight illumination or to extend the photoperiod.

If greenhouse facilities are not available for growing the seedlings during the winter months, the seed may be stored over winter and the embroys cultured in the early spring when the seedlings may be grown in cold frames and then transplanted directly to the garden. The embryos of seed that has been in dry storage for a period of months or even years may be cultured as successfully as the embryos of freshly harvested seed. In fact vigorous, healthy seedlings have been obtained by culturing the embryos of seed that had been stored at room temperature for twelve years.

The procedure outlined above is the result of four years of experimentation and tests to determine optimum conditions for the growth of the excised embryos and young plants. By growing seed in field conditions and in the greenhouse the cycle from seed to flowering was reduced to less than a year, in contrast to the two or three years normally required to obtain bloom. Tests are n in progress to determine the conditio under which the seedlings should grown in order to obtain bloom from higher proportion of the plants the fi year.

Enthusiastic hybridizers will not ove look the advantages of the embryo cu ture technique. Since it is possible obtain successive generations of iris yearly intervals, more rapid progress ca be made in the development of new vari ties. Of significance, too, is the fact th seedlings can be obtained from cross that are difficult to make or that produ but few viable seeds or seeds that refu to germinate.

Many important varieties of iris orig nated from such crosses: the famous var ety DOMINION, for example, and the an cestors of our modern tetraploid ta bearded iris. The true intermediate ir which are hybrids between early-bloom ing dwarfs and later-blooming ta bearded sorts, also the hybrid WILLIA MOHR and all of its first generation hy brids are relatively sterile and produc but few seeds. Reproduction of thes would have met with much less succes under ordinary circumstances.

Recognition of the need for an effec tive method of breaking the dormanc of the seed and obtaining bloom fro seedlings in a shorter period of tin than normal resulted in these exper ments on embryo culture. It was espec ally desirable to obtain a higher per cer of germination from crosses that wer difficult to make or that produced fe viable seed. Undoubtedly, future exper ence will suggest various modification but in its present form the embryo cu ture technique is a practical, reliabl method of speeding seedling productio in iris, and removing the uncertainty an delay caused by the prolonged dormanc of the seed.

* * *

Univ. of N. H. photo

How Durham, New Hampshire, liberated itself. Prof. Funkhouser spraying a rampant roadside poison ivy vine with the community equipment and one of the modern herbicides; Mrs. Funkhouser beside the same plant a few weeks later. It is already dead and no longer a menace, but the surrounding desirable vegetation and the soil are entirely uninjured

THE TOWN WITH NO POISON IVY

Dorothy S. Towle

Condensed from *The American Home*, June 1945

EACH spring and summer used to bring a painful, inconvenient epidemic of poison ivy to the village of Durham, New Hampshire. The handsome, but insidious weed covered stone walls and tree trunks along the sidewalks and even extended its unwelcome presence into gardens. The problem was so grave that the local garden club decided to do something about it.

The members first secured all available literature on the subject, and supplemented this with the results of weed-killer tests that had been carried on by the College of Agriculture of New Hampshire University. For the campaign they chose ammonium sulphamate ("Ammate") which, when applied in solution to the surface of foliage and other green parts, is soon absorbed and gradually carried by the sap to all parts of the plant, effectively killing it.

After much experimentation with hand sprayers, a portable pressure sprayer mounted in the rear of an automobile was found most satisfactory. With a garage air pump it was possible to build up a tank pressure of 50 to 60 pounds, which sprayed the plant poison in a forcible, fine, misty spray.

With this equipment the Garden Club launched a systematic attack on the enemy. They covered the center of the village first, main streets, yards, and vacant lots, and then moved to the outskirts of the town.

The campaign required money, of course, but not much. Fifty dollars and volunteer labor did the job, and the financing was taken care of by the Garden Club, and grateful citizens.

As well as the reward of gratitude and praise for freeing their community from a nuisance, the Garden Club was awarded a cup, given by a New Hampshire resident, Bertha Damon, author of "A Sense of Humus," which goes to the club in the State that has done an outstanding piece of work in any year.

With this striking example of what can be done through organized attack, why don't other communities do likewise?

Copyright 1945, The American Home Magazine Corporation,
444 Madison Avenue, New York 22

N. Y. Nat. War Fun

Fall Rose Garden Day at the Botanic Garden. Left to right: Miss Annamary Dicke Miss Barbara Berchwald, Philip A. Benson, George S. Avery, Jr., Carl Whitmore, Michae Tuch, Mrs. Lambertus C. Bobbink, Mrs. George White, Mrs. Ruth Nathan, Martin F Jacobus, Lambertus C. Bobbink, Mrs. Walter V. Cranford, Miss Margaret Cranford an Mrs. Robert Livingston Clarkson

WITHIN THE BROOKLYN BOTANIC GARDEN

"NEW WORLD" ROSE CHRISTENED AT FALL ROSE GARDEN DAY

Fall Rose Garden Day, October 11, 1945 was a unique event in the annals of the Garden. Fortunately the day was fair and mild so that the ceremonies were held in the Rose Garden, a novel departure from previous occasions. The program was arranged by the New York National War Fund Committee, with the Garden acting as host. The affair was ushered in by radiocast patriotic songs, so that all the way from the dainty sweetbriers at the south end to the "Overlook" at the north, the atmosphere was charged with martial music. Annamary Dickey, Metropolitan Opera star, sang severa numbers, and closed with the Nationa Anthem. Miss Barbara Berchwald, Concert Pianist, rendered some beautifu selections.

The feature of the afternoon was th christening of a new rose furnished fo the event by Mr. Lambertus C. Bobbin of Bobbink & Atkins. According to Mr Martin R. Jacobus, the well-known hybridizer, who produced the new rose, i is a cross between "Chateau de Clo Vougeot" and "Crimson Glory," two hybrid teas, but it reveals unmistakabl

lyantha characteristics which he sus-
cts are recessive in "Crimson Glory."
he new rose is of the "floribunda" type,
rk velvety crimson in color and is
eliciously fragrant. It was christened
New World" by Dr. Avery, "to serve as
symbol of new hope for a shattered
orld" and was accepted for the New
ork National War Fund by Mrs. Robert
ivingston Clarkson, Chairman of the
Vomen's Division. Others who spoke
riefly were Mr. Philip A. Benson, Presi-
ent of the Dime Savings Bank of Brook-
n, and Chairman of the Governing
ommittee of the Garden, who presided;
Ir. Carl Whitmore, President of the
Iew York Telephone Company, and
hairman of the New York National
Var Fund; Mrs. Ruth Nathan, Brook-
n's "Fighting Lady"; Mr. Martin R.
acobus; Mr. Lambertus C. Bobbink.
Irs. Walter V. Cranford, one of the co-
onors of the Rose Garden, was present
n the speakers' platform with her daugh-
er, Miss Margaret Cranford.

After the ceremonies in the Rose
arden, which ended with the planting of
New World" bushes by Mr. S. R.
illey, the Garden's rose grower, mem-
ers of the Garden and their guests were
nvited to tea in the rotunda of the Lab-
ratory Building, the Woman's Auxiliary
acting as hostesses, assisted by the Garden staff.

Planting the new rose. Left to right: S. R. Tilley, Mrs. Robert Livingston Clarkson and George S. Avery, Jr.

Arthur Harmount Graves

EMPLOYEES' VICTORY GARDENS AT THE BROOKLYN BOTANIC GARDEN

Two years ago, in 1943, the first Vic-
ory Gardens were planted at the Brook-
yn Botanic Garden. Unexpectedly it
vas decided to have a Harvest Show, and
no one was more surprised than the em-
loyees themselves when they saw their
wn vegetables washed, polished, and
rtistically displayed in the Rotunda of
he Laboratory Building. Judges found
t difficult to select prize winning exhibits
ut of such a wealth of handsome vege-
ables. The next year, in 1944, the hurri-
ane ruined many gardens everywhere,
and when the Civilian Defense Volunteer Office needed a Victory Garden display, it was from our employee gardens as well as the demonstration garden that specimen vegetables were selected.

We worked our 20 x 25 foot plots in spare time, not with exhibits in mind, but to raise food for home use. Doubtless we were able to maintain a higher standard of nutrition for our families, and at a substantial saving in a period of rising prices, thanks to our Victory Gardens.

View of the victory gardens of the Botanic Garden employees

Most of the gardens were carefully planned and well cared for. While 1943 brought the best yield, the over-all average for the three seasons was about 500 pounds of produce per garden per season. Thirty gardens gave us a total of 22½ tons of fresh vegetables in three years.

Approximately 50 kinds of vegetables are suited to our climate, and of these an impressive variety of about 35 was planted. The following grew with outstanding success: tomato, bush bean, lettuce, onion, radish, carrot, beet, cabbage, broccoli, parsley, kohlrabi, New Zealand spinach, kale, chard, leek, celeriac, pepper, rutabaga, endive, and various herbs. In 1945, tomatoes, broccoli, peppers and eggplants did poorly, but in the previous two seasons so many good quality beans and tomatoes were grown that our gardeners put up a sizable supply for the winter. Other vegetables were also canned r dehydrated.

Our more adventurous gardeners t d out new varieties of vegetables: B , Oak Leaf, and Great Lakes lettuce, wh h they especially liked, and Celtuce d Tampala. Several vegetables, long n cultivation but uncommon in home g - dens, gained popularity. For exam e, many gardeners discovered Chinese c - bage, kohlrabi, New Zealand spin n, chard, and leeks as well as tomatoes n non-commercial varieties.

One of the most valuable "harve " was the experience of cooperation n which a spirit of friendly rivalry s combined with generosity and helpfuln s. A neighbor's success was enjoyed as o 's own; a neighbor's failure to spray, w d or cultivate was frowned upon, since - glect of one garden endangered oth s. Discussions and comparisons were v - able. The more experienced grow s were generous with good advice as ll as with surplus seedlings and crops.

Because home grown vegetables e unsurpassed in flavor and freshness a number of us hope to continue grow g our own. The Brooklyn Botanic Gar n "field," despite city conditions, has - doubtedly been a highly successful c - munity Victory Garden project.

NATALIE H. BOWEN,
Gardene

LIVING MEMORIALS

Daniel Tatkon of P.S. 241 planted a tree at the Brooklyn Botanic Garden on November 20. The occasion—a memorial tree planting ceremony held at the Garden to honor the men and women from the Brooklyn schools who served their country in World War II. The program, attended by six hundred representatives of the schools, students, teachers, and parents, marked the initial planting of a series of trees to be "living memorials" in the Garden, gifts of the schools of Brooklyn.

Highlights of the program in the a i- torium, presided over by the Hon. Le is L. Fawcett, trustee of the Garden, we : a message from the Board of Educati n, read by Dr. Elias Lieberman, Associ e Superintendent of Schools in New Yo ; "Living Memorials," by Dr. George S. Avery, Jr., Director of the Garden; n address by Dr. G. V. Brown, Principal f Public School 131; and "Wide Horizo ," by Miss Frances Miner, Curator of E - mentary Instruction. One hundred fl s of the allied nations flanked the aisles

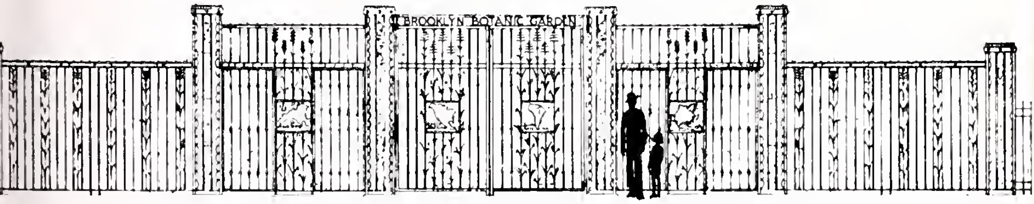
On the knoll beyond the laboratory uilding, the flag-bearers surrounding, Daniel Tatkon made a token planting of n *Oxydendrum;* three similar trees were lanted immediately following the ceremony near the wild-flower garden. The rogram closed with "America the Beautiful," led by the Glee Club of Girls' Commercial High School.

A plaque marks the tree planted—next year its foliage will be scarlet against the dark greens on the knoll. In the library a volume has been deposited, "Trees, Living Memorials," which contains a record of the tree planting ceremony and a page for each of the schools which is honoring its war heroes in this memorial.

A NEW EASTERN PARKWAY GATE

Mr. and Mrs. Michael Tuch, of Brookyn, have generously provided funds for he erection of a new gateway on Eastern Parkway, one of the principal entrances o the Garden. The design of the gate will include in conventionalized form the principal cereal grasses of the earth—corn, wheat and rice. These three grains were the basic food plants of early man: corn for the Indians in our hemisphere, wheat for the primitive peoples of North Central Europe and rice for the Orientals of East Asia. The central section will show, in bas relief, maps of North and South America superimposed on conventionalized stalks of Indian corn. Surmounting this section are the words *Brooklyn Botanic Garden.* The section to the left, with two exit gates, will contain a map of Europe superimposed in a similar way on stalks of wheat, while that on the right will show a map of Asia with stalks of rice.

The Garden is honored to have Mr. and Mrs. Tuch as its civic-minded neighbors and friends.



PROPOSED
MEMORIAL · GATE ·
· FOR ·
· EASTERN · PARKWAY · ENTRANCE ·
· BROOKLYN · BOTANIC · GARDEN ·
GIFT OF MR. AND MRS. MICHAEL TUCH

* * *

OUR NEW EDITOR OF PLANTS & GARDENS

Beginning with the second volume of PLANTS & GARDENS we are fortunate in having Mr. John C. Wister take over the editorial duties.

Graduating from Harvard in 1909, Mr. Wister studied in the Harvard School of Landscape Architecture and the New Jersey Agricultural College, working in landscape architects' offices in New York and Philadelphia until 1917. Since 1919 he has been engaged in the practice of landscape architecture in the latter city.

Horticulture has held an important place in his interest and background. In his own garden he has specialized in azaleas, daffodils, irises, lilacs, and tree and herbaceous peonies, bringing together extensive collections of varieties.

He was one of the organizers of the American Iris Society, serving as President for 15 years. He has been Secretary of the American Rose Society, Vice President of the John Bartram Association, and he also has been a member of the Visiting Committee of the Harvard Botanic Garden. He has served as Chairman of the Committee on Horticultural Varieties of the American Association of Botanical Gardens and Arboretums, and in 1942 he was Chairman of the Advisory Council of the Five Counties of the Philadelphia Region and of the Victory Garden Committee of the State.

For several years Mr. Wister has be Secretary of the Pennsylvania Hortic tural Society and he has been Director the Arthur Hoyt Scott Foundation Swarthmore College since its foundi a well known center for progressive velopments in horticulture.

He also has acted as a judge at ma of the most important flower shows, bo here and abroad, and has lectured many cities of the country, as well as smaller communities; and, since his wo has taken him to many parts of t country, he understands the different c matic conditions and the types of pla and plant treatment necessary for gard success. For his many years of serv to horticulture he has been award numerous medals by horticultural soc ties and garden clubs.

Mr. Wister has published extensive in the leading garden periodicals on wide range of horticultural subjects. has published several books, includi "The Iris" (1927), "Lilac Cultu (1930), "Bulbs for American Garde (1930), and "Four Seasons in Yo Garden" (1936). He has edited "Lila for America," which is the report f 1941 of the Committee on the Survey Lilacs, conducted by the American Ass ciation of Botanical Gardens and Abo tums.

* * *

THE ANNUAL REPORT OF THE GARDEN

The full Report will soon be mailed to all members, and to others upon request. In addition to the 1944–1945 fiscal year report, it includes information on the educational work of the Garden, scientific search, "Gardens within a Garden," a publications.

* * *

INDEX TO VOLUME I

1945

*An * following a page number indicates an illustration.*

Aphids, Giant oak 110
Aquatics, wet soil plants 97
Ascension Island, Hydroponics 235
Aul, Henry B. 84
Autumn coloration 135, 138
Avery, George S., Jr. 3, 52, 67, 70, 131, 182, 195, 206

Barton, Lela V. 174
Beetle, Mexican bean 109*
  Striped cucumber 109*
Bellflowers—Campanula 210*
Bindweed control 53*
Birds in the Garden 122*
Botanic Garden
  Annual Report 252
  Laboratory building 2*
  Waterlily pool 66*
  Winter scene 194*
  Within the 63, 125, 189, 248
Bowen, Natalie H. 250
Brooklyn, George Currie's 127
Brunson, Arthur M. 222

Campanula 210*
Cancers, Do plants have 184
Caparn, Harold A. 68
Chemotherapy—a method of plant pest control 116
Chrysanthemum arcticum hybrids 168
Chrysanthemum varieties, Producing new 171
Chrysanthemums
  Cascade 150*
  Cathedral of Notre Dame modelled in 144*
  Classification of 160
  Greenhouse culture of large-flowered 155
  Growing hardy 161
  Growing outdoors 152
  Hybrid Korean—their history 165
  Hybrids—De Petris 168*, 169*
  Plastic 145
  Winter hardiness 163
City garden, Leeks from a 60*
Clarke, Elizabeth 101
Close, Albert W. 227
Colored inserts
  Chrysanthemums No. 3
  Shrubs No. 1
  Waterlilies No. 2
Corn
  Hybrid vigor 221*
  Principal types 223*
Cumming, Alex. 165
Cuttings
  Hydrangea 141*
  Rooting with plant hormones 140

Damping off 62
Dandelion eradication 55*
Davids, Captain Richard C. 235
Defoliation of vegetables 121
De Petris, V. R. 168
Dioecious shrubs 32
Dipping cistern and wall fountain 85*
Disease control in the home garden 119
Doney, Charles F. 18, 138
Downer, Henry E. 161

Entrance garden 196*, 197*
Editor of Plants & Gardens, New 252

Fisher, George M. 215
Foundation planting, An attractive 137*
Free, Montague 56, 88, 145
Friend, R. B. 113

Front yard, An American 68*, 69*
Fruit thinning 234*

Gager, C. Stuart, memorial fund 122
Gate
  New Eastern Parkway 251*
  Richard Young, Cover, No. 1*
Gillies, George H. 155
Grass—and lawns 70
Grass plots—treated 207*, 208*, 209*
Graves, Arthur H. 11, 105, 135, 198, 249
Greenhouse, Small 181*
Grow your own in 1945 59, 62
Grubs, White 112*

Heart's desire 126
Heron, Green 122*
Holley, W. D. 163
Hollies, Christmas 203
Home garden, Disease control 119
Hope, Claude 227
Hormones
  Rooting cuttings with 140
  Student research with 189
Horticulture, "Hows" and "whys" of 128
House plants
  In summer 76
  Why they fail 56
Hydroponics, Ascension Island 235

Iris seed, Embryo culture 241
  Culture bottles with seedlings 244*
  Pot culture of iris seedlings 245*
  Removing embryo from seed 242*
  Transferring embryo to culture bottle 243*
Insect control operations 113
Insect pests and their control 108
Insects, "Biting" and "sucking" 108*

Jenkins, Dorothy H. 76
Johnson, Elizabeth Bindloss 140
Jones, Donald F. 218
Jordan, William E. 64, 112, 118

Keller's party, "Willie" 63
Knee gardens 182*

Lamson, Mary Deputy 4
Laurie, Alex 230
Lawn provides an ideal setting 71*
Lawns, weeds, and 2-4-D 206
Layout of the small place 4, 68, 133, 1
Leaf miner, Beet 111*
Lilacs, Too many 215
Link, Conrad B. 201, 203
Lotus, East Indian 97*
  Seed and tubers 104*
Lotus motif, East Indian 103*
  Egyptian 102*

Manuring, Balanced 231
Memorials, Living 250
Miner, Frances M. 190
Morrison, Gordon 226
Mosnat, H. Roy 171
Moss, Sphagnum 227*, 228*

Name, What's in a 6
Nicol, Hugh 231

Oaks—leaves and acorns 7*
Ogg, W. G. 231
Ortloff, H. Stuart 133

Panama-hat plant, *Carludovica palma* 190
  Inflorescence 191*
  Fruit 192*
Persoon's Icones 64
Plant propagation, Class in 189*
Plants, How to buy 17, 51, 58
Poinsettia
  Mystery flower 198
  For and after Christmas bloom 201
Poison ivy eradication 247*
Poke is poisonous 63
Pool
  Formal, with flagged area 87*
  Garden 84
  Garden of "Nyssa" 95*
  Informal, at edge of garden lawn 8
  Iris Kaempferi in 83*
  Lily 85*
  Natural 93*
  Tropical waterlily 66*
Popcorn, Hybrid 222
Pyenson, Louis 108

Quackenbush, Amanda 218

Randolph, L. F. 241
Rock garden
  In winter, Cover, No. 4*
  Waterside plants in, Cover, No. 2*
Rose Garden Day, Fall 248*
  "New World" rose christened at 248
  Planting the new rose 249*
Rusk, Hester M. 97

Scale insects
  Florida red 110*
  Oyster-shell 110*
Scenes, Winter 224*, 225*
Scott, Ernest L. 152
Seed germination, Problems 174
Seedlings
  Cotoneaster divaricata 178*
  Dictamnus albus 176*
  Herbaceous peony 179*
  Rose hybrid 177*
  Trillium grandiflorum 180*
Seeds of *Melilotus alba*, Impermeable, 175*
Shaw, Ellen Eddy 63
Shrubs for special uses 18
  Acid soil 19
  City conditions 36
  Dry soil 29
  Fragrant flowers 39
  Ground covers 27
  Hedges 37
  Light, sandy soil 26
  Long blooming period 44
  Seashore 24
  Shade 30
  Showy berries 41
  Uncommon 46
  Wet soil 22
Sitka spruce gall 111*
Slate, George L. 233
Smith, Glenn M. 222
Soil testing 230
Sprays and dusts, Modern 122
Squash bug 111*
Stoddard, E. M. 116
Stoutemyer, V. T. 227
Stream and bank planting 100*
Sugar maple 130*
Svenson, H. K. 6, 78, 160, 192
Sweet gum 136*

Tea grows in Brooklyn 64
Tilley, Sidney Russell 126*
Tomato—pollinating blossoms 219*, 220*
Towle, Dorothy S. 247
Tree, The living 11

Uncle Sam, gardener in gravel 235
Utter, L. Gordon 122

Vegetables
  Cross pollination 226
  Hybrid 218
Victoria regia 78
Victory gardens
  Anton Hubert 61*
  Employees' 249, 250*
Vines 33

Water garden, Back-yard 94*
Water gardens 83
Waterlily 88
  Classification 96
  Story 101
  Way of life 105
Weed-killing chemicals 52
Weeds, Lawns, and 2–4–D 206
Westcott, Cynthia 119
White, Philip R. 184
Winter scene in the Botanic Garden 194*
Wire-worm 112*
Woodland garden 4*, 5*
Worms, Cabbage 109*
Wright, Richardson 210

BOOK NOTICES

Jenkins, Dorothy H. Annual Flowers from Seed Packet to Bouquet 112
Wilson, Helen Van Pelt. Perennials Preferred 118

AMONG THE CONTRIBUTORS TO THIS ISSUE

Dr. Arthur M. Brunson, Senior Agronomist, and Glenn M. Smith, Associate Agronomist, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Captain Richard C. Davids, U. S. Army.

George M. Fisher, Landscape Architect and Consultant Farm Forester at Lawrence, Kansas.

Dr. Donald F. Jones, Geneticist in Charge, and Amanda Quackenbush, Assistant, Connecticut Agricultural Experiment Station.

Alex Laurie, Professor of Horticulture at Ohio State University, Columbus, and Secretary-Treasurer of Roses Incorporated.

Dr. Conrad B. Link, recently appointed Horticulturist at the Brooklyn Botanic Garden. He received his Doctor's Degree at Ohio State University, and was later Assistant Professor of Floriculture at Pennsylvania State College.

Gordon Morrison, Director of Seed Breeding and Research, Burgess Seed & Plant Company, Galesburg, Mich.

Dr. W. G. Ogg, Director of the Rothamsted Experimental Station, and Dr. Hugh Nicol, Associate. Both are connected with the Imperial Bureau of Soil Science.

Dr. L. F. Randolph, Professor of Botany at the New York State College of Agriculture, Cornell University, and Cytologist, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture.

Alice Recknagel Ireys, graduate of the Cambridge School of Landscape Architecture. She has had an office in New York City for several years and has done work on large housing projects, as well as on small homes.

George L. Slate, Assistant Professor of Pomology, New York Agricultural Experiment Station at Geneva.

Dr. V. T. Stoutemyer, Associate Horticulturist, Albert W. Close, Principal Scientific Aide, and Claude Hope, Assistant Horticulturist, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Dorothy S. Towle, engaged in Home Economics and Agricultural Publicity for the University of New Hampshire

Richardson Wright, Editor of House & Garden, and Chairman of the International Flower Show Committee, which will resume its Annual Show in March, 1946.

BROOKLYN BOTANIC GARDEN

Scientific, Educational, and Administrative Officers

SCIENTIFIC AND EDUCATIONAL

GEORGE S. AVERY, Jr., Ph.D., *Director*
ARTHUR HARMOUNT GRAVES, Ph.D., *Curator of Public Instruction*
ALFRED GUNDERSEN, Docteur de l'Université (Paris), *Curator Emeritus*
WILLIAM E. JORDAN, B.S., *Librarian*
CONRAD B. LINK, Ph.D., *Horticulturist*
FRANCES M. MINER, M.A., *Curator of Elementary Instruction*
GEORGE M. REED, Ph.D., *Curator of Plant Pathology*
ELLEN EDDY SHAW, M.A., *Curator Emeritus*
HENRY K. SVENSON, Ph.D., *Curator of the Herbarium*
BARBARA SHALUCHA, M.S., *Assistant Curator of Elementary Instruction*

RALPH CURTISS BENEDICT, Ph.D., *Resident Investigator (Ferns)*
RALPH H. CHENEY, Sc.D., *Resident Investigator (Economic Plants)*
ELIZABETH REMSEN VAN BRUNT, *Honorary Curator of Culinary Herbs*

MICHALENA LE FRERE CARROLL, *Instructor*
ELIZABETH CLARKE, A.B., *Curatorial Assistant*
CHARLES F. DONEY, M.S., *Assistant Horticulturist*
WILLIAM H. DURKIN, *Curatorial Assistant*
ESTHER ANN HUEBNER, A.B., *Instructor*
SALLY KELLY, M.A., *Research Fellow*
HESTER M. RUSK, A.M., *Instructor*
MARGARET F. PIPER, A.B., *Research Assistant*
MARGERY H. UDELL, *Curatorial Assistant*

LOUIS BUHLE, *Photographer*

ADMINISTRATIVE

THOMAS A. DONNELLY, *Secretary and Accountant*[1]
EDNA PALMITIER SCHACHT, *Acting Secretary*
FAY D. MONTROSS, *Business Office Assistant*
CHARLOTTE J. NICHOLSON, *Business Office Assistant*

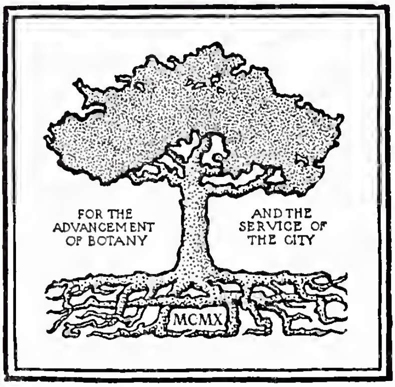
LOUIS BUHLE, *Custodian*
CHARLES F. DONEY, M.S., *Registrar*
CONSTANCE P. ELSON, B.A., *Secretary to the Director*

LAURA M. BREWSTER, *Stenographer*
VIRGINIA A. CLAY, *Stenographer*
ELIZABETH DEAN HOFFMAN, A.B., *Stenographer*

[1] U. S. Army, from April 1, 1942.

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS


FOR THE ADVANCEMENT OF BOTANY
AND THE SERVICE OF THE CITY
MCMX

VOLUME II, NEW SERIES
1946

LANCASTER PRESS, INC., LANCASTER, PA.

Contents

No. 1, Spring, 1946

Cover ... Willows along the Garden Brook
Frontispiece ... Basking Ridge White Oak
Announcement ... George S. Avery, Jr. 3
Layout of the Small Place ... Janet Darling 4
Tree Forms ... John C. Wister 7
Tree Families ... Henry K. Svenson 10
Trees for Special Purposes ... Charles F. Doney 15
Trees for Lawn and Garden ... Henry E. Downer 27
Nut Trees ... John W. Hershey 30
Trees for City Streets ... E. A. Piester 33
Trees to Avoid on the Small Place ... Gertrude M. Smith 37
Unusual Trees ... Laura L. Barnes 39
Ornamental Crab Apples for Flower and Fruit ... Donald Wyman 42
How to Transplant Trees ... Arthur F. Paul 44
How to Prune Trees ... Stanley W. Bromley 48
How to Have Healthy Trees ... H. Gleason Mattoon 50
The Town Forest ... Harris A. Reynolds 52
A Hemlock Arboretum ... Charles F. Jenkins 56
Annuals ... Nellie B. Allen 58
Within the Brooklyn Botanic Garden ... 61
Among the Contributors to this Issue Page 3 of cover

Except where otherwise noted: drawings by Maud H. Purdy;
photographs by Louis Buhle.

No. 2, Summer, 1946

Cover ... Tree Rose—Miss Flora Mitten
Frontispiece ... Rose Garden of the Brooklyn Botanic Garden 66
Director's Letter ... 67
A Year-round Garden ... Mary Deputy Lamson 68

Articles on Roses:

Rose Species ... Henry K. Svenson 72
The Rose as a World Plant ... J. Horace McFarland 77
Old Garden Roses ... Gertrude Albion Wright 79
Outstanding New Roses ... Eugene S. Boerner 85
Hardy Enduring Roses ... John C. Wister 87
Roses for Severe Climates ... Richard S. Wilcox 90
Hardy and Healthy Roses ... Walter and Josephine Brownell 93
Rose Testing ... C. Eugene Pfister 97
Old Roses ... Ethelyn E. Keays 98
How to Grow Roses of Exhibition Quality ... John B. Carson 100
Maintenance of the Rose Garden ... Gertrude M. Smith 103
How to Grow Roses in the City ... Sidney Russel Tilley 107
Use of Embryo Culture in Rose Breeding ... Walter E. Lammerts 111

Miscellaneous Articles:

Wall Gardens ... Dorcas Brigham 112
How to Help Street Trees ... Carl J. Schiff 115
Recent Advances on the Weed-killing Front ... George S. Avery, Jr. 117
Grafting: New Information from an Old Practice ... Ray F. Dawson 119
Within the Brooklyn Botanic Garden ... 121
  Conference on Community Planting for Civic Beauty ... 121
  New York Flower Show Exhibit ... 126
Among the Contributors to this Issue ... Page 3 of cover

Except where otherwise noted: drawings by Maud H. Purdy,
except the one on page 120, which is by Margaret F. Piper;
photographs by Louis Buhle.

No. 3, Autumn, 1946

Cover .... Cranberry-bush, Viburnum Opulus
Frontispiece .... Willows and Pool in the Botanic Garden 130
Director's Letter 131
Lilliputian Landscapes .... Frederick W. G. Peck 132
Articles on Wild Flowers
Can We Hope to Tame the Wild Flowers? .... Edgar T. Wherry 135
Families of Wild Flowers 143
How to Grow Wild Flowers for Pleasure .... Minnie May Johnson 144
Wild Gardens .... A. F. W. Vick, Jr. 150
Wild Flower Conservation in New England .... Kathryn S. Taylor 155
Ground Covers Under Trees .... Hester M. Rusk 161
Notes on Wild Plants 165
Calochortus .... Elmer C. Purdy 170
A City Wild Flower Garden .... Henry K. Svenson 174
Miscellaneous Articles
American Daffodil Selections .... Jan de Graaff 180
Some Hybrids of Lilium Willmottiae .... F. L. Skinner 185
"Operation Ragweed" .... Philip Gorlin 187
Within the Botanic Garden 190
Among the Contributors to this Issue .... Page 3 of cover

Unless otherwise credited, drawings by Michalena L. Carroll and Margaret F. Piper. Photographs by Elsie M. Kittredge or Louis Buhle unless otherwise credited.

No. 4, Winter, 1946

Cover .... Willows in winter, Brooklyn Botanic Garden
Authors whose Articles Appear in this Issue .... Page 2 of cover
Frontispiece .... Ice after the storm, Brooklyn Botanic Garden 19
Director's Letter 195
Articles Condensed or Reprinted
We Need Wilderness .... *National Parks Magazine* 19
Small Shade Trees for Small Properties .... *American Nurseryman* 20
Making New Chestnut Trees .... *Yankee Magazine* 20
How To Use DDT .... *American Forests* 205
Before You Build .... *American Home* 208
Vats Full of Vittles .... *Collier's* 21
Care of the Small Greenhouse .... *Arboretum Bulletin,* University of Washington 21
Manures or Chemicals? .... *The Home Garden* 21
Medicine from Earth .... *Fortune* 21
Disease Takes Increasing Toll of Elm Trees .... *New York Herald Tribune* 22
The Biggest Bargain You Can Find .... *House Beautiful* 22
H–F Day .... *The New Yorker* 228
Columnar Trees Worthy of Growing .... *American Nurseryman* 23
The End of the Boxwood Leaf Miner .... *Flower Grower* 23
How to Give Daylilies a Perfect Setting .... *Flower Grower* 23
Christmas Decorations
Begin with the Tree .... Mary C. Seckman 23
Trim the House .... Ellen B. Carder 23
Choose Interesting Material .... Elizabeth B. Merriam 239
Make the Wreaths and Garlands .... Isabel Zucker 24
Deck the Hearth .... Percy I. Merry and Ruth P. Merry 24
Selected List of Recent Non-technical Books, Magazine Articles, and Experiment Station Bulletins 24
Within the Brooklyn Botanic Garden 25
Index to Volume 2 25

Unless otherwise credited, drawings by Michalena L. Carroll; photographs by Louis Buhle.